SYNOPSIS OF THE IPNOPIDAE (PISCES, INIOMI)

WITH DESCRIPTION OF TWO NEW ABYSSAL SPECIES

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GILL (1884) was the first to use the family name Ipnopidae. Prior to that the genus *Ipnops* was referred to i.a. the Scopelidae (GÜNTHER 1887). Four genera have been described, *Ipnops, Bathymicrops, Bathytyphlops,* and *Ipnoceps.* The last is now considered a synonym of *Ipnops* (see below). The three genera have much in common, but they differ in certain characters which some ichthyologists consider so important that the disagreement might justify the establishment of separate families for each of the three genera (MEAD 1966). However, in the present paper all the genera are referred to one family only, the Ipnopidae.

Family characters: Long and mostly slender fishes with a more or less depressed head and flattened abdomen. The gill slits are very wide, and the anterior gill arch ends close to the symphysis of the lower jaw. No pseudobranchs present. The lower jaw slightly protruding. Two separate patches of vomerine teeth. The dorsal fin placed in advance of the anal fin. No adipose fin. The ventral fins, with 8 rays, are large and clasped, forming a basket under the anus, the ovopore, and the genital papilla, all of which are placed much closer to the base of the ventral fins than to the anal fin. Hermaphrodites with the testicular component lying as a small string medio-dorsally in the gonad. The number of precaudal vertebrae varies from 16 to 25. The scales are deciduous. A lateral line running along the midline of the body.

All measurements are taken in accordance with HUBBS and LAGLER (1958), except that the symphysis of the upper jaw is used as the anteriormost point and not the protruding lower jaw. The urostyle is not included in the vertebral counts. All morphometric characters are given in percentage of the standard length. A number in parenthesis gives the average value for the character in question. When a character forms less than 10 % the uncertainty factor has been put at 0,1, between 10 % and 50 % at 0,5, and over 50 % at 1.

The oceanographic terms used are those proposed by BRUUN (1956 and 1957).

Material examined herein:	Specimens, incl. type(s)
Ipnops murrayi Günther, 1878	13
Ipnops agassizi Garman, 1899	15
Ipnops meadi n.sp.	21
Ipnops specimens	2
Bathymicrops regis Hjort and Koefoed, 1912	7
Bathymicrops brevianalis n.sp.	2
Bathytyphlops sewelli (Norman, 1939)	2
Bathytyphlops marionae Mead, 1958 .	1

Generally, the condition of the material is rather poor. Very often the head is not intact, and the fin rays are broken. One explanation is the fragility of these fishes, and, at least regarding those from the "Galathea" Expedition, the gear used and the depths of the localities involved that large quantities of material were caught and kept in the gear for a relatively long period. Furthermore, most of the specimens examined seem to have shrunk somewhat.

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Key to the genera of Ipnopidae:

1. The dorsally directed large eyes covered by a thin, unpaired, bony membrane formed by the frontals and parietals ..... *Ipnops* Günther, 1878 (= *Ipnoceps* Fowler, 1943)
2. The very small eyes placed more or less laterally above the upper jaw; frontals and parietals unmodified.
   a. 10-14 well-developed gill rakers on first and second arches. Ventral fins well in advance of the dorsal fin ..... *Bathymicrops* Hjort and Koefoed, 1912
   b. A single well-developed gill raker in the angle between the epibranchiale and ceratobranchiale. Ventral fins just anterior to the dorsal fin ..... *Bathytyphlops* Nybelin, 1957

Ipnops Günther, 1878

Ipnoceps Fowler, 1943.

Since GÜNTHER described the genus very few specimens have been reported upon, viz.:

	Specimens
GÜNTHER (1878 and 1887) "Challenger"	4
GOODE and BEAN (1896) "Blake"	2
GARMAN (1899) "Albatross"	3
GILCHRIST[1] (1908).....	1
NORMAN (1939) John Murray Exped....	3
FOWLER (1943) "Albatross"	3
MEAD[2] (1966) "Oregon"	9+?
Present paper (1966) "Galathea".....	30

Generic characters:

Long and slender fishes with the frontals and parietals forming a thin bony plate covering the eyes. A few, small teeth on the vomer and in most cases also on the palatines. Well-developed gill rakers on the anterior arch and moreover relatively long rakers on the second and third arches. THEISEN (1965) gave a thorough description of the cranial morphology.

The type species of the genus *Ipnops* is *I. murrayi* Günther, 1878. GÜNTHER's type material included four specimens, three from two Atlantic stations and one from off the Philippines. GÜNTHER did not select a type-specimen or indicate the type locality. However, GREY (1956) designated "Challenger" St. 133 (35°S, 20°W) as the type locality. Furthermore, the specimen on which GÜNTHER based his discription and illustration was also caught at St. 133. It is thus appropriate to choose this specimen as the lectotype (Brit. Mus. Cat. No. 8, 260, 202). GÜNTHER's type material evidently belongs to two different species, as the three Atlantic specimens ("Challenger" Sts. 124 and 133) agree and correspond to all the *Ipnops* material known from the Atlantic Ocean, while the Philippine specimen ("Challenger" St. 198) belongs to the new species *I. meadi.*

FOWLER (1943) described a new genus, *Ipnoceps.* It "differs from *Ipnops* chiefly in the uppermost or simple pectoral ray with its upper edge dentated or irregularly serrated". However, my examination of GÜNTHER's type material showed that the large specimen from St. 133 had the upper, long ray in the sinistral pectoral fin serrated in the distal fourth (Pl. XV, Fig. 1), a feature also found in one of the "Galathea" specimens. The reason why the serration is so rarely observed might be that most often parts of the pectoral fins are broken in the net. In all other respects the two are very much alike and it would be reasonable to consider *Ipnoceps* a synonym of *Ipnops.* (Actually, it is not the upper ray in the pectoral fin that is serrated, but the second upper ray, as a very small first dorsal ray is present partly hidden under the skin at the basis of the serrated ray).

Figs. 1 and 2 show some of the meristic characters of the *Ipnops* specimens examined herein (51 specimens). The number of gill rakers of the specimens in Fig. 1 is an average of the rakers from the left and right arches. As indicated by the different signatures the material can be split into three groups. Two specimens considered as possible hybrids are kept separate (▼).

1. The group signified by (■), representing *I. agassizi* Garman, 1899, includes the individuals referred to *I. agassizi* and *I. pristibrachium,* the John Murray Expedition material originally referred to *I. murrayi* by NORMAN (1939), and parts of the "Galathea" material (Table 4, p. 57).

2. The intermediate group signified by (○), representing *I. murrayi* Günther, 1878, comprises the lectotype and two more specimens of *I. murrayi* from the "Challenger" Expedition, the specimens

1. The specimen mentioned by GILCHRIST (1908) is lost (PENRITH in litt.), and three of the "Galathea" specimens were sectioned for anatomical studies and are thus unfitted for the present treatment.
2. An unknown number was caught at "Oregon" St. 2821 (MEAD 1966).

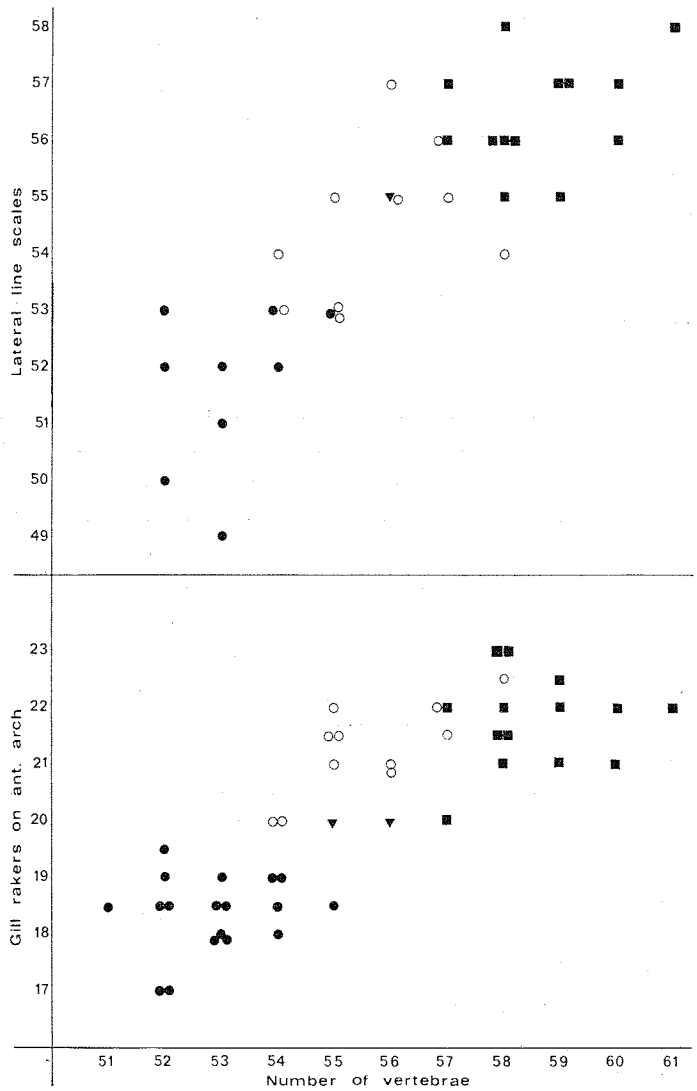


Fig. 1. Variation of the number of "Gill rakers on the anterior arch", "Lateral line scales", and "Vertebrae" in the genus *Ipnops*. Symbols: *I. murrayi* Günther, 1878 (○), *I. agassizi* Garman, 1899 (■), *I. meadi* n.sp. (●), *Ipnops* specimens (▼).

from the "Blake", and from the "Oregon" Expedition, i.e. all the Atlantic *Ipnops* material (Table 3, columns 1-6).

3. The third group signified by (●), representing a new species, *I. meadi,* consists of the major part of the "Galathea" material, the specimen caught by the "Challenger" in the Celebes Sea, and the "Albatross" specimen from off Peru (Table 5, p. 60).

No essential differences are found among the morphometric characters of the *Ipnops* species. One character "Length of head" shows an allometric growth (Fig. 3).

Among the *Ipnops* species, *murrayi* and *agassizi* are the most closely related. This is evident from almost all the meristic characters and also from the presence of otoliths and of the very small upper pectoral ray. Furthermore, these two species have the same bathymetrical distribution (Table 1). Maybe *I. murrayi* and *agassizi* should be considered as subspecies with different geographical distributions. (See also p. 61).

Biology:

Bottom fishes found at abyssal depths in a temperature interval of 1,9°-3,9°C. *I. murrayi* and *agassizi* were caught at depths from 1392-3475 m and *meadi* from 3310-4970 m.

Otoliths are found in *murrayi* and *agassizi,* while they are absent in *meadi,* a feature which might have biological significance. The presence or absence of otoliths has nothing to do with the method or period of preservation. The mouth is large, provided with small pointed teeth, and the gill rakers are numerous and well-developed, on the three anterior arches. The *Ipnops* species, equipped with this effective sieve, apparently feed on small animals as well as on large prey. Stomach and intestine contained but little food. Crustaceans dominated in the

Table 1. Bathymetrical distribution of the *Ipnops* species: Number of specimens caught in different depth intervals.

	1000–1500 m	1500–2000 m	2000–2500 m	2500–3000 m	3000–3500 m	3500–4000 m	4000–4500 m	4500–5000 m
I. murrayi		10	1	2	2			
I. agassizi	1	5	2	7				
I. meadi					1	6	7	7
Ipnops specimens ("Galathea" Sts. 217 and 279)					1			1

food remains which could be identified, and in three cases dorsal felt from the polychaete *Aphrodite* was found. (Similar remains were observed in the stomachs of five specimens of the brotulid fish *Acanthonus armatus* Günther, 1878 (NIELSEN 1965), indicating that this polychaete forms an important part of the food of abyssal fishes). Moreover, a fish-scale was found. The presence of a single scale (4×3 mm) does not prove that *Ipnops* is a fish eater, as the scale may have been swallowed accidentally together with other food from the bottom. The gonads and the reproduction have been treated on p. 72.

MUNK (1959) showed that the cephalic organs in *Ipnops* are modified eyes. The position on top of the head suggests a benthic occurrence of this genus. Similar to other deep-sea fishes degenerate features in the eyes are found in *Ipnops* (MUNK 1965).

Ipnops comprises three species of which the type species, *murrayi,* is known in about 15-20 specimens, *agassizi* in 15 specimens, and *meadi* in 21 specimens. K.P. ANDERSEN (1966) has by using statistical methods (principal components and discriminant functions) shown that the *Ipnops* material belongs to three different groups. Table 2 shows a comparison between the more important differences.

Key to the species of *Ipnops*

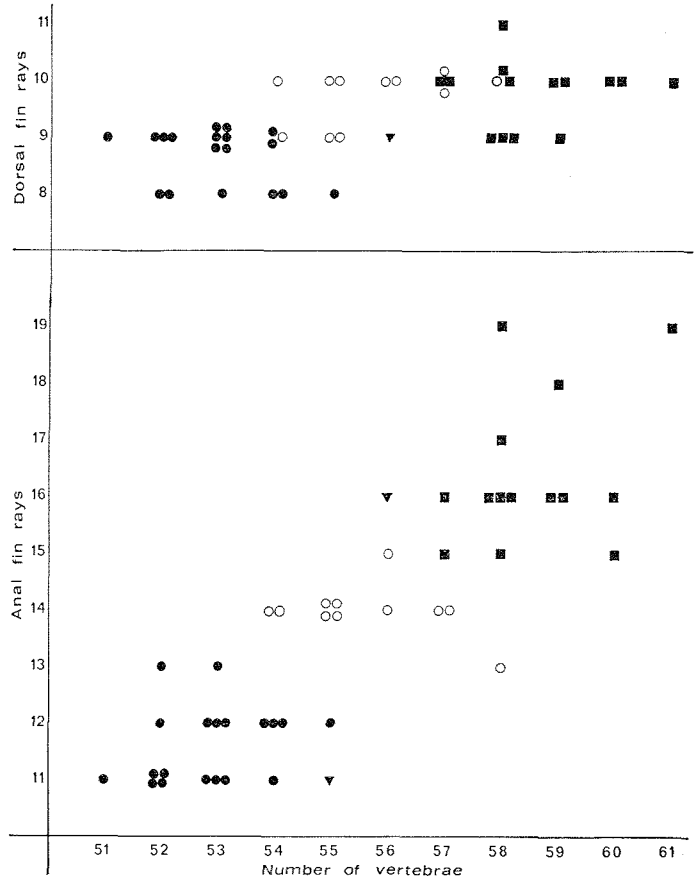
1. Number of anal fin rays 13-19; gill rakers on the anterior arch 20-24; vertebrae 54-61; lateral line scales 53-58; otoliths present.
   a. Anal fin rays 13(14)15; pectoral fin rays 13(13)15; vertebrae 54(56)58 ... *I. murrayi* Günther, 1878
   b. Anal fin rays 15(17)19; pectoral fin rays 13(15)16; vertebrae 57(59)61
   I. agassizi Garman, 1899 (= *I. pristibrachium* (Fowler, 1943))
2. Number of anal fin rays 11(12)13; gill rakers on the anterior arch 17(18)20; vertebrae 51(53)55; lateral line scales 49(52)53; otoliths absent ..... *I. meadi* n. sp.

Table 2. Major differences in the *Ipnops* species.

	I. murrayi	*I. agassizi*	*I. meadi*
Number of specimens	11	15	21
Dorsal fin rays	9(10)10	9(10)11	8(9)9
Anal fin rays	13(14)15	15(17)19	11(12)13
Pectoral fin rays	13(13)15	13(15)16	14(15)16
Gill rakers on ant. arch	20(21)23	20(22)24	17(18)20
Lateral line scales	53(55)57	55(56)58	49(52)53
Vertebrae	54(56)58	57(59)61	51(53)55
Pores on lower jaw	small	small	large
Upper pectoral ray	short	short	long
Otolith present	yes	yes	no
Geographical distribution	Atlantic Ocean	Indo-Pacific area	Indo-Pacific area
Bathymetrical distribution	1555-3475 m	1392-2820 m	3310-4940 m

(For remarks, see Table 3, p. 54).

Fig. 2. Variation of the number of "Anal fin rays", "Dorsal fin rays", and "Vertebrae" in the genus *Ipnops*. (For symbols see Fig. 1).



Ipnops murrayi Günther, 1878
(Pl. XIV, Fig. 1)

Material examined (13 specimens):

1) Lectotype (std. l. 131 mm); "Challenger" St. 133, west of Tristan da Cunha (35°41'S, 20°55'W); 3475 m; globigerina ooze; trawl; bottom temp. 1,9°C; 11-10-1873. Brit. Mus., London. Cat. No. 8, 260, 202.
2) 1 specimen; "Challenger" St. 133. Idem. Cat. No. 8, 260, 203.
3) 1 specimen: "Challenger" St. 124, off Brazil

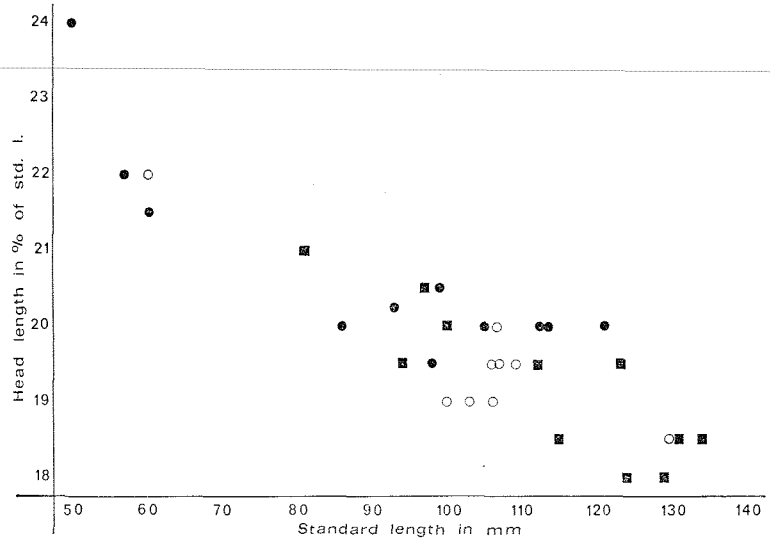


Fig. 3. Allometric growth of "Length of head" in the genus *Ipnops*. (For symbols see Fig. 1).

Table 3. Comparison of examined specimens of *Ipnops murrayi* and *Ipnops* specimens.

	Ipnops murrayi						*Ipnops* specimens	
	Lectotype "Challenger" St. 133	"Blake"		"Oregon"		Total variation	"Galathea"	
		USNM 101371	M.C.Z. 28079	St. 2577 4 specimens	St. 2820 4 specimens		St. 217 P 23367	St. 279 P 23341
Meristic characters								
Standard length	131	103	116	60-107	100-113	60-131 [11	111	92
Dorsal fin	10	9	9	10	9-10	9(10)10 [11[2]	9	–
Caudal fin	17	–	–	19	19	17(19)19 [8	18	19
Anal fin	13	14	14	14	14-15	13(14)15 [11	16	11
Ventral fin (d-s)	8-8	8-8	8-8	8-8	8-8	8-8 [11	8-8	–
Pectoral fin (d-s)	-15	-13	13-13	13/14-13	13-13/14	13(13)15 [9	–	–
Branchiostegal rays (d-s)	12-12	11-10	–	10/11-10/11	-11	10(11)12 [5	–	–
Gill rakers on[1] anterior arch d	22	21	21	20-22	20-22	20(21)22 [11	20	20
Gill rakers on[1] anterior arch s	23	22	21	20-	20-22	20(21)23 [10	20	20
Lateral line scales	54	55	–	53-55	53-57	53(55)57 [10	55	–
Vertebrae	58	55	55	54-57	54-57	54(56)58 17-19+35-40 [11	17+39	55
Morphometric characters in % of standard length								
Head	18,5	19,0	–	19,0-22,0	19,0-20,0	18,5-22,0 [9	–	–
Depth at anterior D	7,3	7,3	–	6,7-7,6	7,0-7,9	6,7–7,9 [10	6,9	7,5
Upper jaw	11,5	12,5	–	12,5-13,5	11,5-12,5	11,5-13,5 [9	12,5	–
Max. width of eye-plates	9,5	9,2	9,1	9,2-10,0	9,3-10,0	9,1-10,0 [11	10,0	8,9
Preanal	66	68	–	66-68	65-67	65-68 [10	63	–
Predorsal	36,0	36,0	–	35,0-35,5	34,0-35,5	34,0-36,0 [10	35,0	–
Base of D	8,6	8,6	–	8,7- 9,4	8,9- 9,6	8,6-9,6 [10	8,3	–
Base of A	15,5	17,0	–	17,0-18,0	17,5-20,0	17,0-20,0 [10	20,5	–
Ant. Anal fin to Caudal base	33,5	32,5	–	31,5-34,0	34,0-36,0	31,5-36,0 [10	37,0	33,5
Ant. D-ray over vertebra no.	18	17	17	17-18	17-18	17-18 [11	18	18
Ant. A-ray under vertebra no.	38	37	37	35-38	35-38	35-38 [11	36	36

Remarks to Tables 2 (p. 52), 3, 4 (p. 57), and 5 (p. 60):

1. The numbers give the total amount of rakers on each arch. With the exception of one specimen there are three rakers on the epibranchial and one in the angle between the upper and lower branch.
2. Numbers in parenthesis give the average value, and a bracket indicates the number of specimens examined for each character.

(10°10'S, 35°30'W); 2926 m; globigerina ooze; trawl; 11-9-1873. Brit. Mus., London. Cat. No. 8, 260, 201.

1 specimen (std. l. 103 mm); "Blake", Gulf of Mexico (24°36'N, 84°05'W); 1747 m. U.S. Nat. Mus., Washington. Cat. No. 101371.

1 specimen (std. l. 116 mm); "Blake", off Bequia (13°N, 61°15'W); 2754 m. Mus. Comp. Zool., Harvard. Cat. No. 28079.

4 specimens (std. l. 60-107 mm); "Oregon" St. 2577, Guld of Mexico (27°48'N, 88°45'W); 1555-2012 m; 30-7-1959. M.C.Z., Harvard. Cat. Nos. 40553 and 40555.

4 specimens (std. l. 100-113 mm); "Oregon" St. 2820, Gulf of Mexico (28°23'N, 88°21,5'W); 1830 m; trawl; 15-7-1960. M.C.Z., Harvard. Cat. No. 41133.

1) Regarding the designation of the lectotype see p. 50.

2) This specimen is in three pieces, and parts of the head are missing. A radiograph did not show any anatomical details (it looked as if the specimen was fixed in Bouin's fluid). Only very few important specific features could be distinguished, viz. "Anal fin rays – 17", "Lateral line scales – 57", "Max. egg diameter – 0,4 mm", and "Std. l. approx. 130-140 mm". The high number of anal fin rays suggests *I. agassizi* rather than *I. murrayi*, but so many important characters are lacking that it is uncertain to which of the two species it belongs.

3) The condition of the specimen is rather poor; the head is gone. A usable radiograph of this specimen was obtained. The following measure-

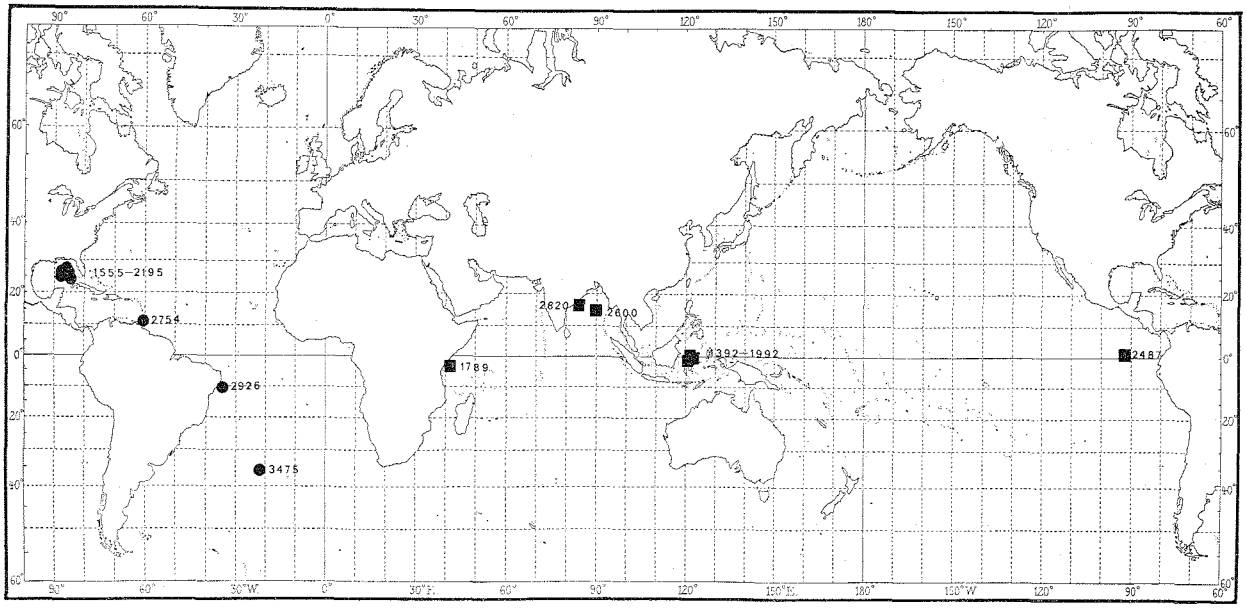


Fig. 4. Distribution of *Ipnops murrayi* Günther, 1878 (●) and *Ipnops agassizi* Garman, 1899 (■). Depths in metres.

ments were taken: "Anal fin rays – 14", "Dorsal fin rays – 9", "Vertebrae approx. 59", "Lateral line scales – 56", "Max egg. diameter – < 0,1 mm", and "Std. 1. (÷ head) – 80-85 mm". Except in the "Number of vertebrae", which is rather high, this specimen agrees with *I. murrayi.*

The few characters which can be distinguished in the two above specimens show how closely *I. murrayi* and *I. agassizi* are related. Additional material from the South-East Atlantic Ocean and from the South-West Indian Ocean may make the differences between the two species still more insignificant.

A detailed description of *I. murrayi* was given i.a. by GÜNTHER (1878 and 1887) and MEAD (1966), so only a few remarks will be made here in addition to Table 3 and Figs. 1 and 2. The dorsal pectoral ray is very short. Seven relatively small pores are placed ventrally on each branch of the lower jaw. Radiographs of two of the specimens did not show any otoliths. However, this may be due to the fact that these specimens, which represent all the *Ipnops* material from the "Blake" Expedition, have been preserved for such a long time that the otoliths have been dissolved. The "Albatross" material, which is of about the same age, normally has otoliths, but a difference in the method of preservation might explain the disagreement. All the specimens examined had teeth on the vomer, while two of them did not have teeth on the palatines. The tooth-pattern is like that of *I. meadi* (Fig. 6, p. 58). Table 3 shows the variation of *I. murrayi.*

GILCHRIST (1908) reported one specimen of *I. murrayi* from a depth of about 1500 m off Cape Point, South Africa, but according to M. J. PENRITH (in litt.) this specimen does not exist any more. On the basis of GILCHRIST's description it is not possible to decide to which of the three *Ipnops* species it belonged.

The colours of the specimens from the "Challenger" and "Blake" Expeditions are much bleached, while the "Oregon" specimens, some of which were caught only five years ago, have the body dark-brown with lighter edges around the scale-pockets. The gill cover, the walls of the gill cavity, the underside of the head, and the mouth cavity are dark-blue.

Gonads and reproduction:

MEAD, BERTELSEN, and COHEN (1964) examined a specimen of *I. murrayi* from "Oregon" St. 2577. The hermaphroditic gonad contained about 900 eggs (see remarks on the reproduction and gonads on pp. 72 and 73).

Distribution:

Benthic in the upper abyssal zone. The lectotype was caught at a depth of 3475 m, and the rest at depths between 1555 and 2926 m. *I. murrayi* is restricted to the Western and Southern Atlantic Ocean (Fig. 4). It has been taken at five stations in

the Gulf of Mexico, at depths varying from 1555 to 2195 m. Material from two of these stations was not examined in the present investigation, viz. "Oregon" Sts. 1303 and 2821 (28°47′N, 87°50′W and 28°47,5′N, 87°57′W) (MEAD 1966).

Ipnops agassizi Garman, 1899
(Pl. XIV, Fig. 2)

Ipnops pristibrachium Fowler, 1943.

Material examined (15 specimens):

1) Lectotype (std. l. 134 mm); "Albatross" St. D 3413, Galapagos Islands (2°34′N, 92°06′W); 2487 m; globigerina ooze; bottom temp. 2,2°C; 5-4-1891. Mus. Comp. Zool., Harvard. Cat. No. 28501.

1) 1 specimen (std. l. 129 mm); "Albatross" St. D 3413. Idem. U.S. Nat. Mus., Washington. Cat. No. 54618.

1) 2) 1 specimen (std. l. 135 mm); "Albatross" St. D 3413. Idem. U.S. Nat. Mus., Washington. Cat. No. 15393.

2) Holotype of *I. pristibrachium* (std. l. 137 mm); "Albatross" St. D 5607, off Celebes (00°04′S, 121°36′E); 1392 m; fine sand; Agassiz trawl; 18-11-1909. U.S. Nat. Mus., Washington. Cat. No. 99508.

1 paratype of *I. pristibrachium* (std. l. 131 mm); "Albatross" St. D 5606, off Celebes (0°16′28″N, 121°33′30″E; 1525 m; grey mud; Agassiz trawl; 17-11-1909. U.S. Nat. Mus., Washington. Cat. No. 99509.

1 paratype of *I. pristibrachium* (std. l. 115 mm); "Albatross" St. D 5608, off Celebes (0°08′S, 121°19′E); 1992 m; green mud; Agassiz trawl; temp. 2,4°C; 18-11-1909. U.S. Nat. Mus., Washington. Cat. No. 99510.

3 specimens (std. l. 81-124 mm); John Murray Exped. St. 118, Zanzibar area (4°05′54″S, 41°10′12″E – 4°17′S, 41°11′48″E); 1789 m; globigerina ooze; Agassiz trawl; temp. 3,04°C; 17-1-1934. Brit. Mus., London.

1 specimen (std. l. 112 mm); "Galathea" St. 299, Bay of Bengal (17°10′N, 84°30′E); 2820 m; mud; herring otter trawl; 24-4-1951. Zool. Mus., Copenhagen. Cat. No. P 23366.

5 specimens (std. l. 90-103 mm); "Galathea" St. 314, Bay of Bengal (15°54′N, 90°17′E); 2600 m; brownish ooze; herring otter trawl; 3-5-1951. Zool. Mus., Copenhagen. Cat. No. P 23360-364.

1) GARMAN (1899) did not mention the number of specimens included in the type material, but there was definitely more than one, as he wrote "Largest specimen 6½ inches in length". Moreover, he did not designate a holotype. Besides the three specimens examined here (Table 4, columns 1-3), MEAD (1966) also mentions another "Albatross" specimen (USNM 149041), but this species has been referred to *I. meadi* in the present paper (Table 5, column 12). This last-mentioned specimen is most probably identical with the catch referred to by GREY (1956 p. 137) from north of Callao, Peru. – The specimen from Mus. Comp. Zool. (Cat. No. 28501) is here designated as the lectotype as it was caught at the type locality and according to a note on the label, GARMAN's illustration of *agassizi* (1899, pl. H, fig. 2) was based on this specimen.

2) The examination is based on a radiograph and some additional information provided by ROBERT H. GIBBS, Jr. (Table 4, columns 3 and 4).

A general description of *I. agassizi* will not be given here, as GARMAN's original description (1899 p. 259-60) is fully adequate. The characters in the key (p. 53), in Table 4, and in Figs. 1 and 2 are sufficient for characterizing the present species. – However, a few additional features will be mentioned: The upper ray in the pectoral fin is hardly visible, as it is often covered with skin. Seven relatively small pores are placed ventrally on each branch of the lower jaw (Pl. XIV, Fig. 4). The otoliths are present in all specimens except for one of the "Albatross" specimens (USNM 54618). All specimens have teeth on the vomer and, with the exception of three, dentigerous palatines. The tooth-pattern in the upper mouth half is similar to that of *I. meadi* (Fig. 6). The number of teeth on the vomer and palatines varies much from one specimen to another, apparently independent of the length of the fish.

From Table 4 it is rather evident that *I. pristibrachium* (Fowler, 1943) is a synonym of *I. agassizi* Garman, 1899. FOWLER (1943) stated that his new species differed from other *Ipnops* species in the following characters: Serration of the upper pectoral ray, anal fin base much longer than in *I. murrayi,* long pectoral rays, broader superocephalic organ, and finally, fins, proportions, and scales all different from what is found in *murrayi* and *agassizi.* The serration of the pectoral ray has already been discussed (p. 50) and the rest of FOWLER's specific characters all fell within the variation of *I. agassizi,* which makes it reasonable to assume that they are

Table 4. Comparison of examined specimens of *Ipnops agassizi.*

	"Albatross"						John Murray Exp. St. 118 3 specimens	"Galathea"		Total variation
	Lectotype MCZ 28501	USNM 54618	USNM 153593	*I. pristibrachium* Holotype 99508	*I. pristibrachium* Paratypes 99509	*I. pristibrachium* Paratypes 99510		St. 299 P 23366	St. 314 P 23360–364	
Meristic characters										
Standard length	134	129	135	137	131	115	81-124	112	90-103	81-137 [15
Dorsal fin	10	9		10	10	9	10	11	9-10	9(10)11 [14
Caudal fin	19	–		19	20	20	19	19	19	19(19)20 [14
Anal fin	18	17		15	15	16	16-19	16	15-19	15(17)19 [14
Ventral fin (d-s)	8-	–			8-8	8-8	8-8	8-8	8-8	8-8 [11
Pectoral fin (d-s)....	14-13	15-			15-15	14-	14/15-14/15	16-15	15/16-15	13(15)16 [13
Branchiostegal rays (d-s)	9-9	10-11			11-11	11-11	10/11-10/12	10-	10/11-10/11	9(10)11 [11
Gill rakers on anterior arch d ..	21	22	24	23	22	22	20-22	23	21-22	20(22)24 [15
Gill rakers on anterior arch s ...	21	21			22	22	20-22	23	21-22	20 (22)23 [13
Lateral line scales...	55	58			56	57	56-58	56	55-57	55(56)58 [13
Vertebrae	59	58		58	57	59	57-61	58	58-60	57(59)61 18-19+38-41 [14
Morphometric characters in % of standard length										
Head	18,5	18,0			18,5	18,5	18,0-21,0	19,5	19,5-20,5	18,0-21,0 [11
Depth at anterior D.	7,5	7,0			7,3	7,8	5,9-6,5	6,9	6,0-6,8	5,9- 7,8 [13
Upper jaw	11,0	11,0			11,0	11,5	12,5-13,0	12,0	12,0-13,0	11,0-13,0 [11
Max. width of eye-plates	8,7	8,7	8,4	8,2	8,6	8,7	9,3-9,9	9,8	9,0-9,3	8,2-9,9 [14
Preanal.....	62	64		63	66	63	63-64	65	61-67	61-66 [14
Predorsal	33,5	35,0		36,0	35,0	34,0	34,0-35,0	35,5	34,0-36,0	34,0-36,0 [14
Base of D	9,0	8,7		10,0	9,8	9,4	8,5-10,5	9,8	8,3-11,0	8,3-10,0 [14
Base of A	26,5	23,5		20,0	20,0	20,0	19,5-24,0	20,5	17,5-25,5	17,5-26,5 [14
Ant. Anal fin to Caudal base	41,0	37,0		34,5	35,0	38,5	34,0-35,5	34,5	33,0-39,0	33,0-41,0 [14
Ant. D-ray over vertebra no.....	18	18		18	19	18	18-20	18	18-19	18(18)20 [14
Ant. A-ray under vertebra no.....	36	37		38	37	37	36-39	38	35-40	35(37)40 [14

(For remarks, see Table 3, p. 54).

conspecific. (In both paratypes of *I. pristibrachium* the dextral long dorsal ray of the pectoral fins was serrated).

The colouration varies much in specimens caught by different expeditions, and depends largely on the presence or absence of scales. The colour of the eye-plates is semi-transparent in the "Galathea" material and blue-white in specimens from earlier expeditions.

Gonads and reproduction:

The variation of the diameter of the eggs from one of the gonads of a 103 mm long specimen (P 23364) is shown in Fig. 14 (p. 73), curve "b". In one of the paratypes of *I. pristibrachium* (99510) the maximal egg-diameter was approx. 0,5 mm, and the testicular string was rather thin. (See general remarks on the reproduction on p. 72).

Distribution:

Bottom fishes found in the Indo-Pacific area (Fig. 4) at depths varying from 1392-2820 metres, i.e. in the upper abyssal zone.

Ipnops meadi n.sp.

(Fig. 5)

Material examined (21 specimens):

Holotype (std. l. 105 mm); "Galathea" St. 238, off Kenya (3°23'S, 44°04'E); 3960 m; globigerina ooze; herring otter trawl; bottom temp. 1,8°C: 13-3-1951. Cat. No. P 23352.

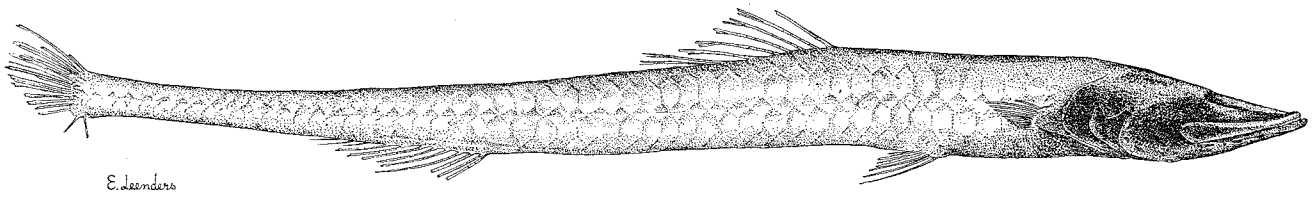


Fig. 5. Holotype of *Ipnops meadi* n.sp. Std. l. 105 mm.

4 paratypes (std. l. 50-113 mm); "Galathea" St. 238. Idem. Cat. Nos. P 23353-356.
5 specimens (std. l. 70-113); "Galathea" St. 234, Madagascar – Mombassa (5°25'S, 47°09'E); 4820 m; globigerina ooze; herring otter trawl; 10-3-1951. Cat. Nos. P 23347-351.
1 specimen (std. l. 92 mm); "Galathea" St. 279, Seychelles – Ceylon (1°00'N, 76°17'E); 4320 m; globigerina ooze; sledge trawl (300 cm); 8-4-1951. Cat. No. P 23342.
1 specimen (std. l. 60 mm); "Galathea" St. 281, Seychelles – Ceylon (3°38'N, 78°15'E); 3310 m; globigerina ooze; sledge trawl (300 cm); 10-4-1951. Cat. No. P 23357.
4 specimens (std. l. 57-121 mm); "Galathea" St. 282, Seychelles – Ceylon (5°32'N, 78°41'E); 4040 m; blackish mud; herring otter trawl; 11-4-1951. Cat. Nos. P 23343-346.
2 specimens (std. l. 86-99 mm); "Galathea" St. 450, Celebes Sea (1°50'N, 119°20'E); 4940-4970 m; herring otter trawl; 21-8-1951. Cat. Nos. P 23358-359.
1 specimen (std. l. 92 mm); "Challenger" St. 198, Celebes Sea (2°55'N, 124°53'E); 3933 m; volcanic mud; trawl; temp. 3,9°C; 20-10-1874. Brit. Mus., London. Cat. No. 8, 260, 204.
1 specimen (std. l. 117 mm); "Albatross" St. D 4658, off Peru (8°30'S, 85°36'W); 4334 m; 14-11-1904. U. S. Nat. Mus., Washington. Cat. No. 149041.
1 specimen (with sectioned head) from "Galathea" St. 234 or St. 282.

With the exception of the "Challenger" and "Albatross" specimens all the material is kept in the Zoological Museum, Copenhagen.

Diagnosis:

I. meadi differs from both *murrayi* and *agassizi* in the following characters (*meadi* mentioned first); Anal fin rays (11-13 *vs.* 13-15 and 15-19); gill rakers on the anterior arch (17-20 *vs.* 20-23 and 20-24); vertebral count (51-55 *vs.* 54-58 and 57-61); lateral line scales (49-53 *vs.* 53-57 and 55-58). Furthermore, *I. meadi* lacks otoliths in contrast to the two other species, and the dorsal ray in the pectoral fin is longer in *I. meadi*. The seven pores in each of the lower jaw branches are considerably larger in *meadi* (Pl. XIV, Figs. 3 and 4). *I. meadi* differs especially from *murrayi* by having more rays in the pectoral fin (14 (15) 16 *vs.* (13) 15).

The species is named after GILES W. MEAD, Museum of Comparative Zoology, Harvard.

Description:

Holotype. The more important meristic and morphometric characters are shown in Table 5, column 1. (See also family and generic characters). – Body long and slender with the abdominal part flattened. The urogenital openings placed under the ventral fins, just anterior to the dorsal fin. Head much depressed, being broader than high. The dorsal roof of the skull is so thin that the brain is visible. The thin frontals and parietals, covering the eyes, end close to the upper jaw symphysis. The lower jaw slightly protruding. The upper jaw forms about 60 % of the head-length. The gill slits are very long (Pl. XIV, Fig. 3). Otoliths not present.

Fins. The fin rays are more or less broken. The anterior ray of the dorsal fin placed over the 16th vertebra and much closer to the snout than to the caudal base (predorsal 37,5 %). The anal fin begins closer to the caudal base than to the anus, under the 34th vertebra. The dorsal ray of the pectoral fin relatively long. The damaged ventral fins apparently formed the "basket", typical of the Ipnopidae.

Scales. No scales remain, but according to the

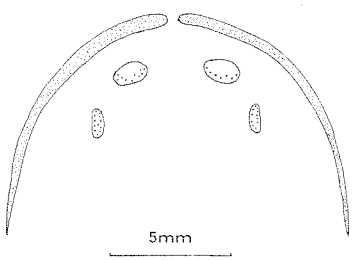


Fig. 6. Dentigerous bones (premaxillare, vomer, and palatine) in the roof of the mouth of the holotype of *Ipnops meadi* n. sp.

scale-pockets the body and the sides of the head have been scaled.

Teeth. Fig. 6 shows the dentigerous bones in the roof of the mouth. The premaxillare (like the dentale) is provided with numerous fine teeth. The vomer and the palatine bear only few small pointed teeth; (the amount of dots on Fig. 6 gives the actual number of teeth).

Gill rakers. Pl. XV, Fig. 2 shows the anterior left gill arch. The rakers are stiff and present in a number of 19, three on the epibranchiale, 15 on the ceratobranchiale and hypobranchiale, and one in the angle. The right anterior arch has only 18 rakers. Well-developed rakers are present also on the second and third arches; the length of the rakers decreases from 3-4 mm on the first arch, 2 mm on the second, to 1 mm on the third. The rakers on the fourth arch are small knots.

Vertebrae and ribs. There is a distinct transition between the caudal and the precaudal vertebrae. Both pleural and epipleural ribs are attached to the 3rd-7th vertebrae. There are also ribs on the anterior caudal vertebrae.

Colour. After 9 years of preservation in formaldehyde and 6 years in alcohol the following colours remain: The body yellow-brown, the abdomen darker, owing to the brown peritoneum which can be seen indistinctly through the skin, and the head, mouth, and gill cavity are dark-brown.

Viscera. The relatively short intestine is only one-third longer than the distance from the anus to the pyloric part of the stomach. Posteriorly it is thin-walled, being thicker closer to the stomach, which is very thick-walled and provided with folds like the anterior part of the intestine. The hermaphroditic gonads (10 mm long) are only half-filled with eggs of different diameters (0,1-0,8 mm, Fig. 14, p. 73). The testes are placed medio-dorsally in the gonads and end in the genital papilla (2 mm long), while the ovaries end in the ovopore just anterior to the papilla. Swimbladder and pyloric coeca not present.

Variation:

In addition to the holotype *I. meadi* is based on 20 specimens, of which only the four from the type locality are considered paratypes. The remaining 16 specimens are from 7 additional stations in the Indo-Pacific area.

Table 5 shows the characters of 20 specimens of *I. meadi*. Some of them are in a rather poor condition, but by means of radiographs many characters could be distinguished. The meristic characters do not vary much (Figs. 1 and 2 (p. 53) and Table 5).

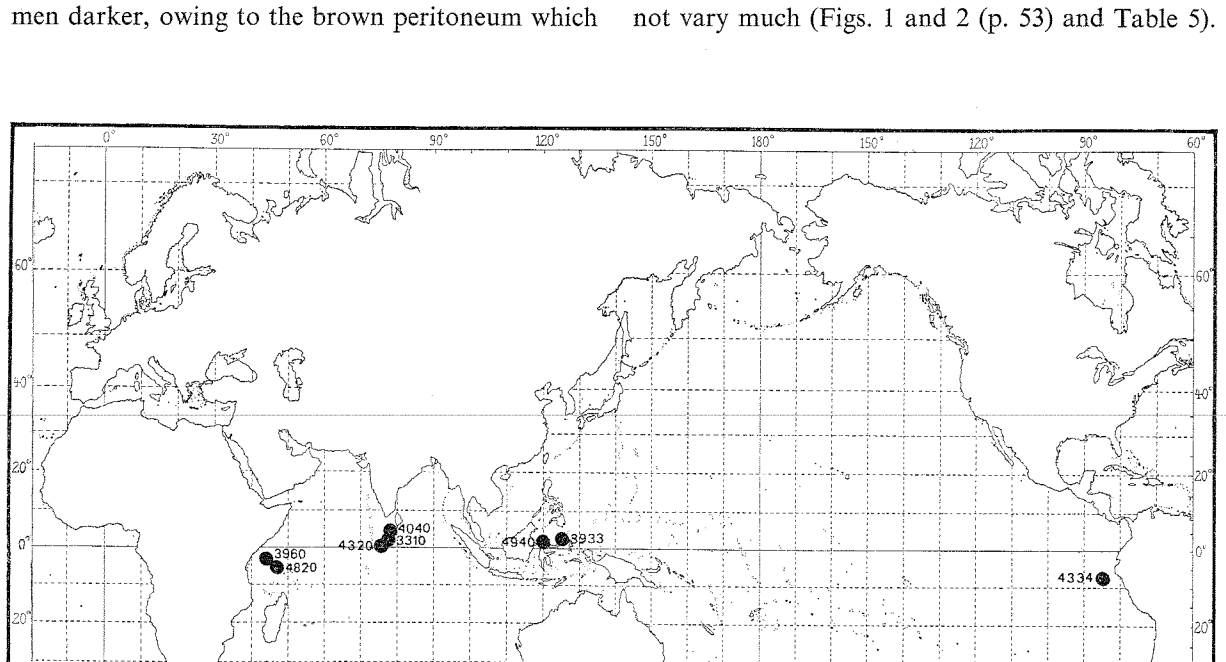


Fig. 7. Distribution of *Ipnops meadi* n.sp. Depths in metres.

Table 5. Comparison of examined specimens of *Ipnops meadi*.

	"Galathea" St. 238					"Galathea"					"Challenger"	"Albatross"	Total variation	
	Holotype P 23352	Paratypes P 23353	P 23354	P 23355	P 23356	St. 234 P 23347–351	St. 279 P 23342	St. 281 P 23357	St. 282 P 23343–346	St. 450 P 23358–359	St. 198 8,260,204	St. D 4658 149041		
Meristic characters														
Standard length	105	113	98	59	50	70-113	92	60	57-121	86-99	92	117	50-121	[20
Dorsal fin	8	9	–	9	8	8-9	8	9	8-9	9	9	8	8(9)9	[18
Caudal fin	18	17	18	–	–	19	19	–	18-19	19	17	–	17(18)19	[14
Anal fin	12	11	12	12	–	11	12	11	11-13	12	11	12	11(12)13	[19
Ventral fin (d-s)	8-8	8-8	–	–	–	8-8	8-8	–	8-8	8-8	8-8	8-8	8-8	[13
Pectoral fin (d-s)	15-15	15-	–	–	–	15-15	14-15	–	15-15/16	15-15	16-16	15-15	14(15)16	[16
Branchiostegal rays (d-s)	10-	–	–	-10	-10	10-10	–	–	10-10/11	10-10	10-	–	10(10)11	[8
Gill rakers on anterior arch d	18	18	–	19	17	18-19	20	–	18-19	18-19	17	18	17(18)20	[17
Gill rakers on anterior arch s	19	19	19	19	17	18-19	19	–	18-19	18-19	17	19	17(18)19	[18
Lateral line scales	51	–	–	–	–	52-53	–	–	49-53	52	50	53	49(52)53	[9
Vertebrae	17+36	51	16+38	18+36	52	52-54	–	53	52-53	–	–	–	51(53)55	[20
						16-17+35-38	17+35		16-17+35-37	16-17+37	16+36	16+39	16-18+35-39	
Morphometric characters in % of standard length														
Head	20,0	20,0	19,5	–	24,0	20,0	–	–	20,0-22,0	20,0-20,5	–	–	19,5(21,0)24,0	[11
Depth at anterior D ...	6,9	6,6	–	6,8	6,0	7,3-7,4	7,2	–	6,2-7,8	7,1	7,6	–	6,2(6,9)7,8	[14
Upper jaw	12,5	12,0	–	–	–	–	–	–	11,5-14,0	12,0-12,5	–	11,0	11,0(13,0)14,0	[9
Max. width of eye-plates	8,5	8,5	8,7	9,8	9,6	9,3	–	–	8,6-9,7	8,4-9,6	8,2	8,1	8,1(9,0)9,8	[14
Preanal	68	66	66	70	79	68	–	–	65-69	64-65	67	67	64(67)70	[15
Predorsal	37,5	37,0	36,0	40,5	40,0	37,5	–	–	36,0-40,5	36,0-37,0	35,0	36,5	35,0(37,5)40,5	[14
Base of D	7,4	8,2	–	7,6	9,0	7,6-8,3	7,1	–	7,0-8,4	7,7-8,2	7,9	7,7	7,1(7,9)9,0	[17
Base of A	13,0	15,0	14,5	15,5	–	12,5-14,0	14,5	–	12,0-15,5	14,0	14,0	15,0	12,0(14,0)15,5	[17
Ant. Anal fin to Caudal base	34,0	33,5	33,0	32,0	34,0	30,5-35,0	33,0	–	30,0-35,0	34,5-35,0	33,0	34,0	30,0(32,5)35,0	[18
Ant. D-ray over vertebra no.	16	17	–	17	17	16-17	17	–	17-18	17	16	18	16(17)18	[17
Ant. A-ray under vertebra no.	34	34	35	36	35	33-35	35	–	34-36	34-35	34	35	33(35)36	[18

(For remarks, see Table 3, p. 54).

The most divergent specimen is that caught by the "Albatross" Expedition. It has six pores placed ventrally on each branch of the lower jaw, while all the other specimens of *I. meadi* have seven pores. Therein it resembles the two *Ipnops* specimens mentioned below. Also the highest vertebral count (55) was found in this specimen which is the only record from the Eastern Pacific (Fig. 7). However, in all other characters this specimen is a typical *meadi*. – Also the morphometric characters show surprisingly little variation. The head-length is apparently the only character which has an allometric growth (Fig. 3, p. 52).

Gonads and reproduction:

Fig. 15 (p. 74) shows the maximum egg diameter found in 25 *Ipnops* specimens, most of which were *meadi*. A gonad was taken from each of two specimens and all the eggs measured. The result can be seen on Fig. 14 (p. 73). A section of the hermaphroditic gonad of the holotype is shown on Pl. XIV, Fig. 5. (More general remarks on the gonads and the reproduction on p. 72).

Distribution:

Three out of six specimens examined contained bundles of dorsal felt from the polychaete *Aphrodite*. This is additional strong proof that *Ipnops* is benthic, for *Aphrodite* definitely lives on the bottom. *I. meadi* differs from the other *Ipnops* species by occurring only in the lower abyssal zone (3310-4940 m). Like *I. agassizi* it is distributed in the Indo-Pacific area (Fig. 7).

Ipnops specimens
(Table 3, columns 7-8)

Material examined:

Specimen a. Std. 1. 111 mm; "Galathea" St. 217, Mozambique Channel (14°20′S, 45°09′E); 3390 m; globigerina ooze; herring otter trawl; bottom temp. 1,6°C; 27-2-1951. Cat. No. P 23367.

Specimen b. Std. 1. 92 mm; "Galathea" St. 279, Seychelles-Ceylon (1°00′N, 76°17′E); 4320 m; sledge trawl (300 cm); 8-4-1951. Cat. No. P. 23341.

The above two specimens have been separated from the rest of the *Ipnops* material since they are intermediate between the three *Ipnops* species (cf. Figs. 1 and 2 (p. 53) and Table 6) in several meristic characters. In Table 6 they are compared, separately, to the three known species, and the characters in which they agree are stated.

Table 6.

Specimen a agrees with:
I. murrayi in: Length of dorsal pectoral ray. Gill rakers on anterior arch. Vertebral count. Lateral line scales.
I. agassizi in: Anal fin rays. Length of the dorsal pectoral ray.
I. meadi in: Absence of otoliths.
Specimen b agrees with:
I. murrayi in: Gill rakers on anterior arch. Vertebral count. Presence of otoliths.
I. agassizi in: Presence of otoliths.
I. meadi in: Anal fin rays. Length of dorsal pectoral ray.

However, in one character they disagree from all other *Ipnops* specimens examined (except for the "Albatross" specimen of *I. meadi)*, viz. in the number of pores found ventrally on the lower jaw branches. The present specimens have six pores, while the number was seven in the rest of the *Ipnops* material. (Pl. XIV, Figs. 3 and 4). The size of the pores was equal to that of *I. meadi*. – Both specimens contained eggs with a diameter of 0,6 mm.

Remarks:

The fact that these two specimens have characters in common with all three species of *Ipnops* may indicate that they are hybrids. – Specimen a might be a combination of *murrayi* or *agassizi* (most similar to *murrayi)* and *meadi* (because of the absence of otoliths). The station at which specimen a was caught is the most south-western *Ipnops* station in the Indian Ocean, i.e. the one closest to the Atlantic Ocean, where *murrayi* is found. – Specimen b was taken at a depth typical of *meadi*. The presence of otoliths suggests a combination with *murrayi* or *agassizi*. – The existence of these two *Ipnops* specimens, combining characters from all three *Ipnops* species, could indicate that *murrayi, agassizi,* and *meadi* are subspecies only, with *murrayi* restricted to the Atlantic Ocean and the two other species with different bathymetrical distributions in the Indo-Pacific area.

Bathymicrops Hjort and Koefoed, 1912

There has been some confusion concerning the authorship of the present genus and the type species *B. regis*. This species was first mentioned and figured in "The depths of the ocean" by MURRAY and

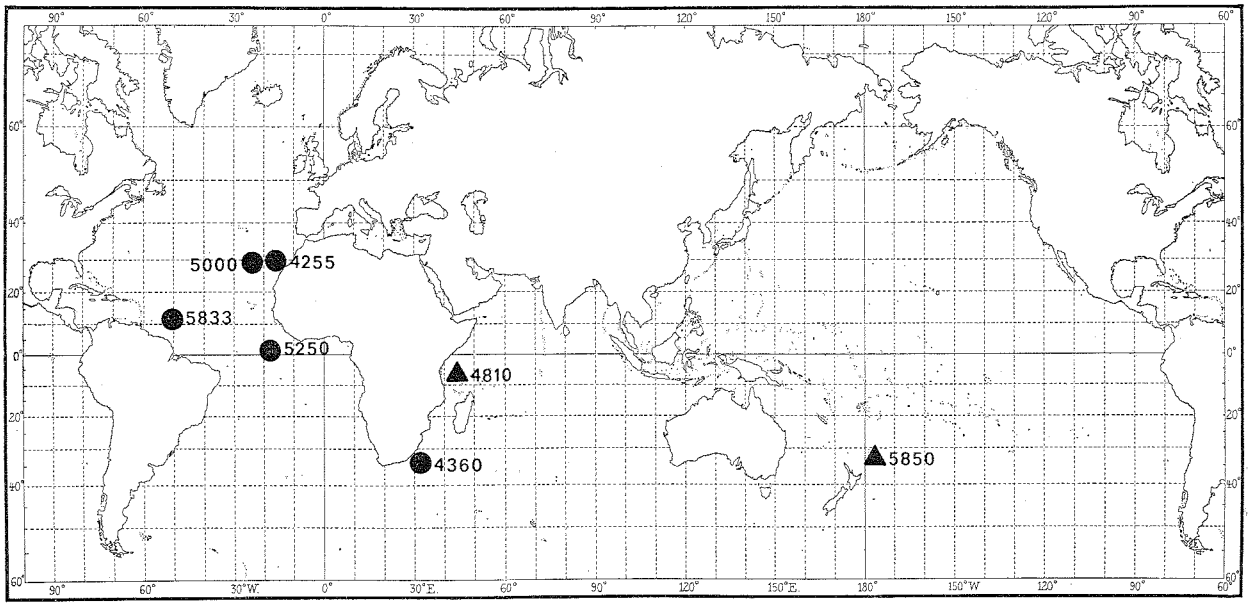


Fig. 8. Distribution of *Bathymicrops regis* Hjort and Koefoed, 1912 (●) and *B. brevianalis* n.sp. (▲). Depths in metres.

HJORT (1912). However, on page 88 of that book it is stated that "to this new fish KOEFOED and I (= HJORT) propose the name *Bathymicrops regis*". This would indicate that KOEFOED and HJORT are the authors. Later, KOEFOED (1927, p. 64-65) made a full description of *B. regis* in which he used the designation n.g. et n.sp. without referring to the publication from 1912 as the description. Consequently, PARR (1928 p. 23) and NORMAN (1939 p. 26) cited "Koefoed, 1927" as the author, while GREY (1956 p. 135), NYBELIN (1957 p. 257), and MEAD (1966 p. 154) all cited "Hjort and Koefoed, 1912".

Generic characters:

The entire body and head covered with scales. Body very slender. The eyes are small and covered with scales, but are still visible. The ventral fins well in advance of the dorsal fin. Well-developed gill rakers (11-14) on the two anterior arches on each side.

Biology:

The following remarks refer to both species of *Bathymicrops,* as they appear to have a uniform biology. – This genus has been found at depths varying from 4255 to 5850 metres (or 5900 m) i.e. at abyssal depths (Fig. 8). BRUUN (1956) found "a certain degree of segregation of the abyssal zone in an upper and a lower subzone" and mentioned *Bathymicrops* as an example from the lower subzone. – The specimens were caught over a soft bottom and in a temperature interval of 1,1°-2,4° C. – Very little food was found in the digestive canal of the three specimens examined (the "Galathea" material). The only recognizable remains were referred to Amphipoda. The mouth of *Bathymicrops* is big enough for relatively large prey to be swollowed whole. On the other hand the long, toothed gill rakers on the first and second arches form a very effective sieve which apparently also allow the utilization of small food-items. These features seem very beneficial for an animal living at depths where food is relatively scarce. – The specimens of this genus do not have many means of communication; the eyes are greatly reduced (MUNK 1965), no luminous organs or swim bladder are present, and the lateral line is poorly developed. However, on two localities the "Swedish Deep-Sea Expedition" caught two and four specimens, which may indicate that they occur in aggregations. – Both species are

Key to the species of *Bathymicrops*

1. Anal fin with 9-10 rays; 76-80 vertebrae; preventral 25,5 % of the std. l.; anterior dorsal fin ray over the 31st.-33rd. vertebrae; no teeth on the endopterygoids ..... *brevianalis* n.sp.
2. Anal fin with 12-15 rays; 65-69 vertebrae; preventral 28,0-30,0 % of the std. l.; anterior dorsal fin ray over the 25th. vertebra; teeth on the endopterygoids ..... *regis* Hjort and Koefoed, 1912

hermaphrodites, but apparently not with interior fertilization (cf. p. 72).

Bathymicrops comprises two species of which the type species, *B. regis,* is represented by 9 specimens and *B. brevianalis,* described in the present paper, is known in two specimens.

Bathymicrops regis Hjort and Koefoed, 1912 (Pl. XVI, Fig. 1)

Material examined (7 specimens):

Holotype (std. l. 91 mm); "Michael Sars" St. 48 (28°54′N, 24°14′W); 5000-5500 m; trawl; 31-5-1910. Zool. Mus., Bergen. Cat. No. 3198.

2 specimens (std. l. 87-89 mm); "Swedish Deep-Sea Exped." St. 313 (29°48′N, 17°39′W – 30°05′N, 17°18′W); 4255-4267 m; trawl; 16-6-1948. Nat. Hist. Mus., Göteborg. Cat. Nos. 1708 and 1709.

2 specimens (std. l. 95-102 mm); "Swedish Deep-Sea Exped." St. 342 (01°03′N, 18°40′W – 00°58′N, 18°37′W); 5250-5300 m; trawl; 16-7-1948. 1 specimen (std. l. 102 mm) in the Nat. Hist. Mus., Göteborg (Cat. No. 1710) and 1 specimen (std. l. 95 mm) in the Brit. Mus., London.

1 specimen (std. l. 93 mm); "Swedish Deep-Sea Exped." St. 363 (12°22′N, 52°00′W – 12°13′N, 51°44′W); 5033-5044 m; trawl; 3-8-1948. Nat. Hist. Mus., Göteborg. Cat. No. 1711.

1. specimen (std. l. 117 mm); "Galathea" St. 194 (34°09′S, 30°45′E); 4360 m; shrimp otter trawl; temp. 1,1°C; globigerina ooze; 7-2-1951. Zool. Mus., Copenhagen. Cat. No. P 23337.

The only two specimens not examined here were caught by the "Swedish Deep-Sea Exped." on St. 342. They were presented to the museums in Paris and Monaco.

Table 7, columns 1-6, shows some of the meristic and morphometric characters of the seven specimens of *B. regis* examined.

Remarks:

During the reexamination of the holotype the major disagreements with the original description were found in the standard length and in the number of anal fin rays, which are 91 mm and 12 rays respectively, while KOEFOED (1927) stated 94,5 mm and 14 rays; (different ways of measuring the standard length may explain the former disagreement).

The number of principal rays in the caudal fin varies from 17-18 except for the specimen from the British Museum which has only 15 rays.

The numbers in Table 7 indicating the amount of rakers on the gill arches should be interpreted thus: The first and last number shows the dentigerous knots, the second and fourth gives the number of well-developed, long and slender rakers, while the middle number stands for a typical, well-developed raker placed in the angle between the epibranchiale and the ceratobranchiale. The Table shows that very often a variation is found between the number of rakers on the left and right arch. Furthermore, the fifth arch is provided with 1-3 small knots.

The number of scales in the lateral line varies rather much (65-75). However, since most of the scales have disappeared it is necessary to count the scale-pockets, a method which especially in the tail region, is not quite safe.

The number of vertebrae varies between 65 and 69. Most of the variation is found in the caudal vertebral region (42-47), while the precaudal vertebral count is more constant (22-23). – The vertebrae have been counted on radiographs, but strangely enough the radiographs of the two specimens from St. 313 only showed the silhouette of the fish and a few obliterate details. All the material from the "Swedish Deep-Sea Expedition" has been kept in the same kind of preservation-liquid for the same period, so this can hardly be the explanation.

The vertebrae (all normal sand-glass shaped) can easily be separated into caudal and precaudal ones, as the haemal arches, the parapophyses, and the ribs are well ossified.

The diameter of the pigmented eye varies considerably (0,4-0,8 % of the std. l.), but it turns out that the smallest specimen has the larger eyes and vice versa, which indicates an allometric growth. Concerning the variation in the snout-length and in the interorbital width see page 67. MUNK (1965) showed that the eyes are heavily degenerated.

The "Galathea" specimen was caught far away from the rest of the specimens known of *B. regis* (Fig. 8). Table 7 enables a comparison between this Indian Ocean specimen and the Atlantic material; some divergences are found, i.a. in the number of vertebrae, the preanal length, and the postorbitale length. However, there seems no reason to doubt that they are conspecific, especially as some of the differences probably can be ascribed to differences in the standard length (117 mm *vs.* 87-102 mm). The greatest disagreement appears in the vertebral count, but the variation is restricted to the caudal

Table 7. Comparison of examined specimens of *Bathymicrops*.

	B. regis						*B. brevianalis*	
	"Michael Sars"	"Swedish Deep-Sea Expedition"			"Galathea"	Total variation	"Galathea"	
	St. 48 Holotype	St. 313 2 specimens	St. 342 2 specimens	St. 363 1 specimen	St. 194 1 specimen	7 specimens	St. 654 Holotype	St. 235 Paratype
Meristic characters								
Standard length	91	87-89	95-102	93	117	87-117	111	114
Dorsal fin	10	9	8	10	10	8(9)10	9	8
Caudal fin	4+17+1	X+17-18+X	X+15-18+X	X+18+X	X+18+X	X+15(17)18+X	1+18+1	1+17+1
Anal fin	12	14-15	12-13	12	14	12(13)15	10	9
Pectoral fin	10-10	9-9	9/10-9/10	9-9	9-9	9(9)10	9-9	–
Ventral fin	8-8	8-8	8-8	8-8	8-8	8-8	7-7	7-7
Branchiostegal rays (d-s)	9-9	8-8/9	8-	–	8-8	8-8/9	10-10	9-10
Gill rakers on ⎫ d	2+4/1/9+1	2+3/1/9+1-2	2+2-3/1/8-9+1-2	–	1+3/1/10+1	1-2+2-4/1/8-10+1-2	1+2/1/8+1	1+3/1/7+1
anterior arch ⎭ s	1+3/1/9+1	2+2-3/1/9+1	1-2+3/1/8-9+1	–	2+4/1/9+1	1-2+2-4/1/8-9+1	1+2/1/9+1	2+2/1/7+1
Lateral line scales	ca. 65	ca. 70	65-70	ca. 70	ca. 75	65-75	ca. 70	–
Vertebrae	22+43	–	22+23+42-44	23+42	22+47	22-23+42-47		
	65		65-66	65	69	65-69	76	80
Morphometric characters in % of std. l.								
Head	17,0	16,5	16,0-17,0	-	15,0	15,0-17,0	16,5	16,0
Depth at ant. D	5,5	5,7-6,0	6,3-6,4	7,0	6,0	5,5-7,0	5,4	4,8
Snout	4,4	3,9-4,0	3,8-4,2	–	3,8	3,8-4,4	5,4	4,8
Dia. of pigmented eye	0,6	0,6-0,8	0,5	0,5	0,4	0,4-0,8	0,5	0,5
Interorbital width	3,3	2,3-3,4	3,0-3,2	–	2,7	2,3-3,4	3,6	2,4
Postorbitale	12,0	12,0-13,0	12,0-12,5	–	11,0	11,0-13,0	11,5	11,5
Premaxillare	14,5	14,0-14,5	13,5-14,5	–	13,5	13,5-14,5	13,0	12,0
Predorsal	41,5	41,5	42,5	41,5	40,0	40,0-42,5	45,0	42,0
Preventral	29,0	28,5	28,5-30,0	29,0	28,0	28,0-30,0	25,5	25,5
Preanal	66	65-66	66	64	62	62-66	69	66
Preanus	36,5	35,0-36,0	34,0-37,0	37,0	36,0	34,0-37,0	32,5	34,0
Ant. anal ray to base of caudal	34,0	33,5-34,0	35,0	37,0	37,0	33,5-37,0	32,0	32,5
Base of dorsal fin	7,9	7,8-8,4	6,9-7,9	8,7	8,7	6,9-8,7	6,0	6,2
Base of anal fin	14,5	15,5-16,5	13,5-15,0	16,0	16,5	13,5-16,5	8,7	8,6

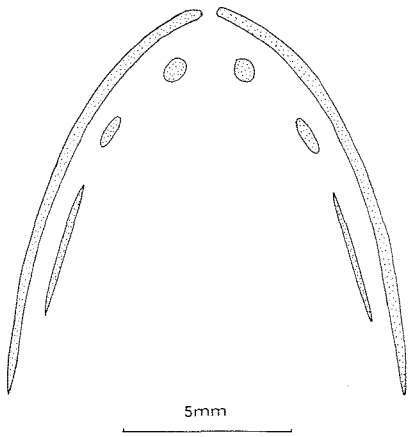


Fig. 9. Dentigerous bones (premaxillare, vomer, palatine, and endopterygoid) in the roof of the mouth of the holotype of *Bathymicrops regis* Hjort and Koefoed, 1912.

vertebrae while they agree in the taxonomically more important precaudal vertebrae.

The teeth (Fig. 9) are somewhat stronger than those found in *B. brevianalis*. Besides the teeth on the palatines a narrow line of teeth (1-2 rows) is also found on the endopterygoids.

In three specimens the abdominal cavity was opened (Pl. XV, Fig. 6). The short intestine is seen between the prominent gonads. The stomach is thick-walled and small with longitudinally running folds. Two small, plump pyloric coeca. The liver is very small. No swimbladder is present. The digestive canal only with a few remains of crustaceans.

A gonad (18 mm long) is shown on Pl. XV, Fig. 5b. There is both a testicular and an ovarian component; the former can be seen as a long, thin string placed medio-dorsally on the gonad. For further information see p. 73. The size-variation of the eggs from this gonad is demonstrated in Fig. 14, curve "d" (p. 73). The maximum egg diameter of the holotype is 0,4 mm while it is 0,5 mm in a 102 mm long specimen from the "Swedish Deep-Sea Exped." St. 342.

Biology:

See the remarks on the biology of the genus *Bathymicrops* (p. 62). It might be added that the stronger teeth and the shorter intestine suggest that *B. regis* has another food-biology than has *B. brevianalis*.

Distribution:

Bathymetrical distribution. The depths of the localities vary from 4255-5250 m. However, the numbers on Fig. 8 give the minimum depths, while, as indicated in the list of material, the depth might vary from 4255-5300 m. KOEFOED (1927) stated the depth for the holotype to approx. 5000 m, but one of the labels attached the type specimen gives the depth to be 5000-5500 m. *B. regis* is believed to live on the bottom.

Geographical distribution. *B. regis* has been caught north of the equator both east and west of the Atlantic Central Ridge and in a single specimen off South Africa (Fig. 8). NYBELIN (1957) stated that since *B. regis* now occurs on both sides of the Ridge "this Ridge consequently forms no unsurmountable barrier between the East and the West Deep-Basins of the North Atlantic Ocean for this species". However, after the "Galathea" caught the specimen in the south-western part of the Indian Ocean and two specimens of the related *B. brevianalis* also in the Indo-West Pacific area there seems no reason to assume that this lower abyssal species should have crossed the Ridge in the North Atlantic Ocean. It could easily have migrated from the common deeper area in the south into the eastern and western Atlantic basins separated by the Ridge. – The relatively many records from the Northeast Atlantic Ocean are most certainly due to the very uneven dispersal of abyssal trawl-stations in the world oceans.

Bathymicrops brevianalis n. sp.
(Fig. 10)

Material examined (2 specimens):

Holotype (std. l. 111 mm); "Galathea" St. 654, Kermadec Trench (32°10′S, 175°54′W); 5850-5900 m; bottom temp. 1,2°C; 18-2-1852. Cat. No. P 23338.

Paratype (std. l. 114 mm); "Galathea" St. 235, Madagascar-Mombassa (4°47′S, 46°19′E); 4810 m; globigerina ooze; herring otter trawl; temp. 1,3°C[1]; 11-3-1951. Cat. No. P 23339.

Both specimens are kept in the Zoological Museum, Copenhagen.

Diagnosis:

B. brevianalis differs from the related species, *B. regis*, in many characters. Some of these are mentioned below with those of *B. regis* in the parenthesis:

Anal fin rays 9-10 (12-15); vertebrae 76-80 (65-

1. No bottom temperature was measured at this station; the record from a neighbouring station was used.

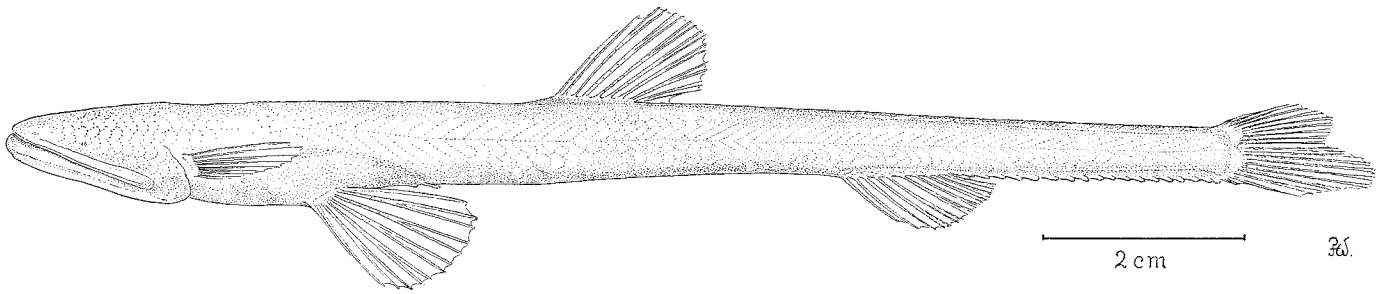


Fig. 10. Holotype of *Bathymicrops brevianalis* n.sp. Std. 1. 111 mm.

69); snout 4,8-5,4 % (3,8-4,4 %); preventral 25,5 % (28,0-30,0 %); base of anal fin 7,4-8,7 % (13,5-16,5 %); the anterior ray in the dorsal fin over the 31 st.-33 rd. vertebrae (over the 25 th. vertebra); most vertebrae cylindrical in form, broader than long (all vertebrae of the typical sand-glass form, longer than broad); no teeth on the endopterygoids (teeth on the endopterygoids).

The specific name refers to the short anal fin.

Description:

Holotype. Most of the meristic and morphometric characters are shown in Table 7, column 7.

The body is long and slender with the abdomen flattened. The anus and the genital papilla are placed much closer to the base of the ventral fins than to the anal fin. The scales on the ventral edge of the caudal peduncle are twisted, giving a serrated appearence. The head is depressed, broader than high. The skull is transparent and the brain is visible through the bones. The eyes are placed deep in the head and covered with skin and scales. The nasal openings are situated closer to the eyes than to the tip of the snout. The lower jaw slightly protruding. Premaxillaries very long, forming 75 % of the head length. Branchiostegal membranes free of isthmus. The gill slits are very long ending midway between the vertical through the eye and the lower jaw symphysis. – No otoliths are seen on the radiograph.

Fins. The anterior ray of the dorsal fin is placed over the 31st. vertebra and somewhat closer to the snout than to the caudal base. The rays are of the same length as the ventral fin rays. Except for the first ray the distal third of the rays is branched. The last ray is split down to its base, like that of the anal fin. The caudal fin with only one ray on each side of the principal rays. The dorsal and ventral principal ray is unbranched while the remaining 16 rays are all branched. The anal fin starts closer to the caudal base than to the anus. Unless the distal part has broken off the three anterior rays are all unbranched. The ventral fins are bent downwards, touching each other and forming a hollow under the anus, the ovopore, and the genital papilla. The pectoral fins are shorter than the ventral fins and all the rays are unbranched.

Scales. Many scales have been lost, mostly on the dorsal part of the body. The scales are circular, cycloid, and rather inclined to shed. Judging from the remaining scales and the empty scale-pockets the entire head, the gill cover, the body, and the base of the caudal fin are scaled. Modified scales were found along the bases of the dorsal and anal fins, where they are larger and more elongate, and on the ventral edge of the caudal peduncle (cf. above). No scales remain along the dorsal edge in the present state of the specimen. – A very indistinct lateral line runs along the middle of the body to the base of the caudal peduncle.

Teeth. Fig. 11 shows the teeth pattern of the dentigerous bones in the roof of the mouth. The premaxillaries are provided with many small, pointed teeth, in 5-6 rows anteriorly and posteriorly

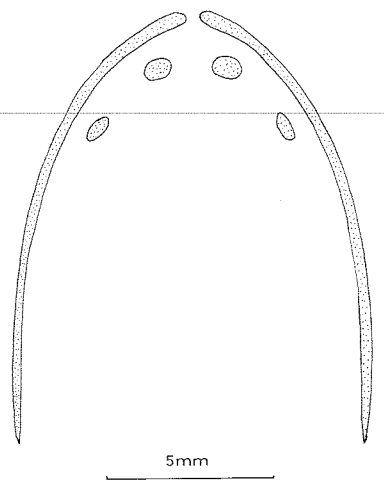


Fig. 11. Dentigerous bones (premaxillare, vomer, and palatine) in the roof of the mouth of the holotype of *Bathymicrops brevianalis* n.sp.

in 3-4 irregular rows; the teeth are largest in the inner row. No teeth in the symphysis. The vomer with two separate blotches covered by teeth (in 2-3 rows) a little coarser than those on the premaxillaries. Each palatine only with a small blotch of teeth placed in 2-3 irregular rows. No teeth on the pterygoids. The mandible with teeth the size of those on the premaxillaries. – The upper pharyngeals provided with teeth like those on the vomer, while the lower pharyngeals have smaller teeth.

Gill rakers. Pl. XV, Fig. 3 shows the anterior arch from the left side (the gill arch is held open by two needles). The long rakers, which number 12, are rather stiff and slender. The ventral part of the anterior arch ends very close to the lower jaw symphysis. The second arch is provided with an equal number of well-developed rakers. The third and fourth arches with rakers formed as small dentigerous knots. The fifth arch has 1-2 knots. The gill laminae are short.

Vertebrae and ribs. Radiographs showed that most of the vertebrae of *B. brevianalis* do not have the typical sandglass form found in *B. regis*. (In three regions of the vertebral column the vertebrae are a little constricted). In the remaining part of the vertebral column, comprising more than 50 %, the vertebrae are cylindrical with a diameter larger than the length of the vertebrae. The presence of constricted parts in the vertebral column appears very abnormal; these are not found in the paratype, where all the vertebrae are cylindrical. – It is not possible to distinguish between caudal and precaudal vertebrae with certainty as the anterior haemal arches and the parapophyses and ribs are not well ossified. – The neural and haemal spines point slightly backwards anteriorly, but become gradually more and more bent when approaching the caudal fin, where the spines are almost parallel to the vertebral column.

Colour. After 13 years of preservation, first in formaldehyde and then in alcohol, the following colour-pattern is found: The parts of the body where scales are absent are red-brown owing to the colour of the underlying tissues, which are seen through the transparent skin. Areas still covered with scales are light brown. The head and the fins are yellowish. The illustration, Fig. 10, was made just after the termination of the "Galathea" Expedition, i.e. about one year after the specimen was caught, and a dark pattern was not present even at that time. In contrast to this some of the *B. regis* specimens from the "Swedish Deep-Sea Expedition" in 1948 still have darker rings around the body. This may indicate that the present species never had a dark pattern.

Viscera. Pl. XV, Fig. 7 shows the holotype with the abdominal cavity opened. The intestine is very long and lies in five bends from the pyloric part of the stomach to the anus. The length is about 55 mm while the shortest distance between the anus and the stomach is 20 mm. The anterior 15 mm of the intestine are thick and provided with several bent folds running in a longitudinal direction; the next 25 mm are very thin-walled without prominent folds, and finally, the last 15 mm are again with thick walls with a reticular pattern inside. The thick-walled stomach is provided with folds, which enlarge its surface considerably. No pyloric coeca present. The liver is much larger than that of the "Galathea" specimen of *B. regis*. In *B. brevianalis* the posterior part of the liver ends far behind the stomach and 12 mm from the anus (std. 1. 111 mm), while in *B. regis* it ends just anterior to the stomach and 25 mm from the anus (std. 1. 117 mm). – No swimbladder present. – One of the gonads (11 mm long) was sectioned and stained. In Pl. XV (Figs. 4 and 5) both the testicular and the ovarian components are recognizable. The larger eggs had a diameter of 0,3 mm.

Variation:

The condition of the paratype is not good. The specimen is stiff and has obviously shrunk. This, together with the bad state of preservation of the viscera, indicate that it was not put into formaldehyde immediately after capture.

The difference between the holo- and the paratype can be seen from Table 7, columns 7-8 (p. 64). No striking differences are found in the meristic characters. Major differences are observed among the following morphometric characters: "Depth at the anterior end of the dorsal fin", "Snout", and "Interorbital width". The smaller depth of the paratype is most certainly caused by the shrinkage mentioned above. It seems more difficult to explain the last two differences. However, these two characters actually depend on the same thing, viz. the position of the eyes. Degenerating organs often show a very high degree of variation and this might explain the above disagreements (the same is found for *B. regis)*.

The paratype has lost almost all the scales on the posterior part of the body, but they are still present both dorsally and ventrally on the anterior

Table 8.

	Bathymicrops regis (88,5–117 mm)	*Bathytyphlops sewelli* (93 mm)	*Bathytyphlops sewelli* (300 mm)	*Bathytyphlops marionae* (279 mm)
1. Depth at dorsal fin in % of std. l.	5,5-7,0	9,1	17,5	16,0
2. Lateral line scales	65-75	ca. 70	ca. 65	64
3. Head compressed	much	moderately	slightly	slightly
4. Eyes in % of std. l.	0,4-0,8 (distinct)	0,9 (distinct)	0,5 (indistinct)	0,7 (distinct)
5. Number of well-developed rakers on the anterior gill arch	12-14	1	1	1

half which is dark-brown. The rest of the specimen is coloured like the holotype.

All the vertebrae are of the same almost cylindrical form with diameter equalling length. There are four vertebrae more than in the holotype. The anterior ray of the dorsal fin is placed over the 33rd vertebra (over the 31st in the holotype).

Because of the bad state of preservation it was difficult to examine the viscera, but a few differences could be observed: The liver is smaller and the intestine is shorter than in the holotype. The gonads are large, containing eggs of variable sizes. The egg-diameter varies from about 0,1 mm to 0,7 mm.

Biology:

(See the general remarks on the biology of the genus *Bathymicrops* on page 62 and of the Ipnopidae on page 74). There might be a difference in the food-biology between *B. brevianalis* and *B. regis,* as the length of the intestine measured from the stomach to the anus forms 50 % of the std. l. in the holotype of the former, but only 30 % in the latter. Furthermore, the dentition is weaker in *B. brevianalis.* However, the modest material and the small amounts of stomach content available of both species prevent any conclusion in this matter. (The holotype contained only the head and parts of the legs of a large amphipod).

Distribution (Fig. 8):

Bathymetrical distribution. The depth of the two localities are 5850-5900 m and 4810 m, which characterize this species as abyssal, as it undoubtedly occurs on or in close connection with the bottom (see page 74).

Geographical distribution. The two only known specimens were caught very far from each other, viz. in the Western Pacific and in the Western Indian Ocean. Presumably, this species has a world-wide distribution, but owing to its deep occurence it is rarely caught.

Bathytyphlops Nybelin, 1957

Bathytyphlops was established on the basis of *Bathymicrops sewelli* Norman, 1939, known from a single specimen. NYBELIN found several characters separating the two genera, but some of these were apparently due to the fact that all his comparative material, which comprised eight specimens of *B. regis,* was much shorter than the holotype of *B. sewelli* (88,5-104 *vs.* 300 mm). In Table 8 a comparison is made between a specimen of *B. sewelli* (std. l. 93 mm) caught by the "Galathea", the holotypes of *B. sewelli* (std. l. 300 mm) and of *B. marionae* (std. l. 279 mm), and of the *B. regis* material (std. l. 88,5-117 mm) regarding characters used by NYBELIN (1957 p. 260) in his diagnosis of the genus.

The addition of characters of the small specimen of *B. sewelli* and of the holotype of *B. marionae* has weakened some of NYBELIN's diagnostic characters. The only unambigous character is No. 5. (It should be kept in mind that none of the additional material was published upon when NYBELIN made the diagnosis). The characters concerning the position of the nostrils has been omitted here.

Generic characters:

The only well-developed raker placed in the angle between epibranchiale and ceratobranchiale of the anterior arch. The body-depth at the dorsal fin is 16,0-17,5 % of the standard length in larger specimens (measured on two specimens 279-300 mm in std. l.). The base of the ventral fins just anterior to the dorsal fin. The anterior ray of the dorsal fin over the 21st vertebra.

The radiographs (Pl. XVI, Figs. 6 and 7) of the posterior caudal vertebrae of *B. sewelli* (std. l. 93 mm) and of *B. marionae* (std. l. 260 mm) demonstrate that the shape of the vertebrae may change with the growth of the fish. In the smaller specimens they are almost cylindrical, while the vertebrae are sandglass-shaped in larger specimens. The vertebrae

Key to the species of *Bathytyphlops*

1. Anal fin rays 16; the only well-developed gill raker (on the anterior arch) is short and thick (2,5 × 1,5 mm in a specimen 300 mm in std. length); the eye is indistinct in large specimens.... *B. sewelli* (Norman, 1939)
2. Anal fin rays 13-14; the only well-developed gill raker is long and relatively thin (11 × 1,5 mm in a specimen 260 mm in std. length); the eye is distinct in large specimens..... *B. marionae* Mead, 1958

of the holotype of *B. sewelli* (std. l. 300 mm) were quite similar to those shown on Pl. XVI, Fig. 7, but the radiograph of *B. sewelli* was not fitted for reproduction.

Biology.

Judging from Fig. 12 it is evident that *Bathytyphlops* has an eurybathic occurrence, as it is found bathyally as well as abyssally, in contrast to *Bathymicrops* which is apparently restricted to the lower abyssal zone. It seems that *Bathytyphlops* feeds on larger prey than do *Bathymicrops* specimens of the same length; the mouth is bigger, the teeth are stronger, and all the gill rakers, except one on the anterior arch, are formed as small spiny knots. Unfortunately, very little food (legs of crustaceans) remained in the digestive canal of the specimen examined. – Examination of one of the gonads from the paratype of *B. marionae* showed that this species is hermaphroditic (further remarks on page 72).

Two species of *Bathytyphlops* have been described, the type species, *B. sewelli,* and *B. marionae*. The former is known in two – and the latter in four specimens.

Bathytyphlops sewelli (Norman, 1939)
(Pl. XVI, Figs. 2 and 3)

Material examined (2 specimens):

Holotype (std. l. 300 mm); John Murray Exped. St. 171 (9°07′06″N, 55°27′06″E – 9°08′48″N, 55°31′48″E); 3840-3872 m; trawl; 28-4-1934. Brit. Mus., London.

1 specimen (std. l. 93 mm); "Galathea" St. 238 (3°23′S, 44°04′E); 3960 m; herring otter trawl; globigerina ooze; temp. 1,8°C; 13-3-1951. Zool. Mus., Copenhagen. Cat. No. P 23340.

Table 9, columns 1-2, shows some of the characters of the two *B. sewelli* specimens. Only quite insignificant disagreements are found among the meristic characters. When comparing the morphometric characters, differences are observed in "Depth at ant. dorsal fin" and in "Diameter of pigmented eye". These disagreements can with certainty be ascribed to differences in the standard length of the two specimens, as the body-form of the holotype is very similar to that of the type material of *B. marionae* (columns 3-4) which is of approx. the same standard length.

When no additional remarks are made, the following is based upon the "Galathea" specimen:

Nasal openings placed midway between eye and snout. The eyes are small and situated close to and over the middle part of the premaxillaries, but are not embedded and covered with skin and scales like the eyes of the holotype. The lateral line is rather prominent running along the middle of the body. The pectoral fins are long, almost reaching the anus. The anal opening is much closer to the base of the ventral fin than to the anal fin. The ventral

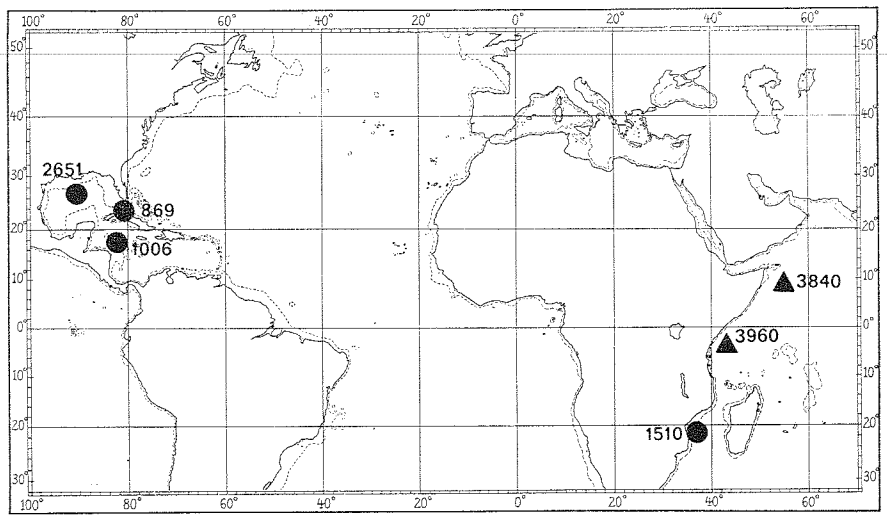


Fig. 12. Distribution of *Bathytyphlops marionae* Mead, 1958 (●) and *B. sewelli* (Norman, 1939) (▲). Depths in metres.

Table 9. Comparison of examined specimens of *Bathytyphlops*.

	B. sewelli		*B. marionae*	
	John Murray Exped. Holotype	"Galathea" St. 238	"Oregon" Holotype	"Atlantis" Paratype
Meristic characters				
Standard length	300	93	279	260
Dorsal fin	11	11	13	12
Caudal fin	5+19+4	6+19+5	X+15+X	X+17+X
Anal fin	16	16	14	13
Pectoral fin	12-12	12-12	12	13
Ventral fin	8-8	8-8	8	8
Branchiostegal rays (d-s)	14-14	14-14	15	17-17
Gill rakers on first arch d	6/1/11	6/1/10	6/1/14	7/1/13
Gill rakers on first arch s	6/1/11	7/1/11	–	7/1/12
Gill rakers on second arch d	5/1/11	6/1/11	–	6/1/13
Gill rakers on second arch s	5/1/11	6/1/11	–	7/1/14
Lateral line scales	ca. 65	ca. 70	64	65
Vertebrae	25+38	24+38	–	25+37
	63	62	63	62
Morphometric characters in % of std. l.				
Head	21,5	23,0	23,0	22,5
Depth at ant. D	17,5	9,1	16,0	–
Snout	7,0	7,7	7,5	7,1
Dia. of pigmented eye	0,5	0,9	0,7	0,9
Interorbital width	8,8	9,3	8,6	8,5
Postorbitale	16,0	15,5	–	16,5
Premaxillare	17,0	18,5	17,0	16,5
Predorsal	41,5	40,0	39,1	40,0
Preventral	38,0	36,5	37,5	37,5
Preanal	67	67	69,6	69
Preanus	43,5	45,0	–	48,0
Ant. anal ray to base of caudal	32,5	35,5	–	31,5
Base of dorsal fin	10,0	9,7	12,7	12,5
Base of anal fin	15,5	16,0	14,0	13,0

fins are so strongly bent downwards that they are clasped. The dentigerous bones are the same as those of *B. regis* (Fig. 9, p. 65). The two circular patches with vomerine teeth are well separated (25-30 teeth on each), the oval palatine-teethpattern also with about 30 teeth, and the pterygoids with a long, thin pattern (2-3 teeth-rows on the middle of the bone). – Pl. XVI, Fig. 4 shows the anterior left gill arch. Only one raker is well-developed while the rest are small, spiny knots. There is a marked difference in the shape of this raker in the two specimens. That of the holotype is very thick (2,5 mm long and 1,5 mm where it is broadest) while it is long and slender in the "Galathea" specimen (3,5 mm long and 0,3 mm broad). The gill laminae are long and thin compared to that found in the *Bathymicrops* spp. – Pl. XVI, Fig. 6 shows that the form of the vertebrae is similar to that of *B. brevianalis*, viz. almost cylindrical. The ribs are very thin and long and only found in connection with the precaudal and the anterior caudal vertebrae. The transition from the caudal to the precaudal vertebrae is very distinct. The first ray of the dorsal fin over the 21st vertebra in both specimens. Two very small otoliths (2 mm) in the holotype, but none visible on the radiograph of the "Galathea" specimen. – The intestine is 50 mm long and arranged in three bends. The direct distance between the anus and the pyloric part of the stomach is only 22 mm. The posterior 5 mm of the intestine are more thich-walled than the rest. The interior surface of the digestive canal is enlarged by irregularly arranged folds. The only stomach content was remains of legs of crustaceans. No pyloric coeca or swimbladder present. The liver is very small. The gonads are hardly developed; only two tiny strings are visible. An ovopore opens anterior to the basis of the papilla. – Several pyloric coeca are developed in the holotype of *B. sewelli* and the gonads contain many eggs.

Biology:

(See general remarks on page 69). Because of the few specimens known only little can be said about the biology of this species. It occurs on the bottom at abyssal depths. – Owing to the poor development of the gonads of the "Galathea" specimen it was not possible to ascertain whether this species is hermaphroditic, like *B. marionae*. However, the presence of an ovopore and other similarities between the two species suggest that *B. sewelli* is also provided with an ovotestes. – Supposing that the present species and the *Bathymicrops* spp. have the same growth rate, the former apparently becomes sexually mature much later than the latter, judging from a comparison between the present "Galathea" specimen (std. l. 93 mm) and the paratype of *B. brevianalis* (std. l. 114 mm) in which well-developed eggs were found.

Distribution:

B. sewelli was found at abyssal depths (3840-3960 m) in the western part of the Indian Ocean (Fig. 12).

Bathytyphlops marionae Mead, 1958
(Fig. 13)

Material known (4 specimens):

Holotype (std. l. 279 mm); "Oregon" St. 1955 (16°48'N, 82°33'W); 1006 m; 17-9-1957. Chicago Nat. Hist. Mus. Cat. No. 64439.

Paratype (std. l. 260 mm); "Atlantis" St. 2991 (23°21'N, 80°23'W); 869 m; 14-3-1938. Mus. Comp. Zool., Harvard. Cat. No. 39394.

1 specimen; "Oregon" St. 2574 (26°34'N, 89°53'W); 2651 m; 28-7-1959.

1 specimen was received from the Mus. Comp. Zool., Harvard (Cat. No. 44878) after the galley proof was ready. (See further remarks on this specimen on page 72).

Only the paratype was examined by the author. Table 9, columns 3-4, gives the characters of the holotype (taken from MEAD 1958) and of the re-examined paratype. A comparison with the characters of *B. sewelli* shows that the two species disagree in several characters. However, many of the disagreements are small enough to be without specific value. Major differences among the meristic characters are found in the number of anal fin rays and branchiostegal rays. Furthermore, the eye is much more developed in this species than in the holotype of *B. sewelli.*

Owing to the adequacy of the original description, little additional information is given:

A radiograph of the paratype showed that all vertebrae are formed like those of the holotype of *B. sewelli,* i.e. in the typical sandglass shape (Pl. XVI, Fig. 7). The transition between the caudal and precaudal vertebrae is very distinct. Ribs present as far back as to above the anal fin. The anterior ray of the dorsal fin over the 21st vertebra. Two small otoliths present.

The anterior gill arch with one well-developed raker in the angle between epibranchiale and ceratobranchiale. The raker is 11 mm long and 1,5 mm broad which makes it quite different from that of the holotype of *B. sewelli* (2,5 × 1,5 mm). The remains of the other rakers are very insignificant (Pl. XVI, Fig. 5).

The viscera were not in too good a condition. No pyloric coeca present. The gonads contain both a testicular and an ovarian component. Eggs of different sizes were found; (maximum diameter 0,5 mm). – See remarks on the biology on page 69.

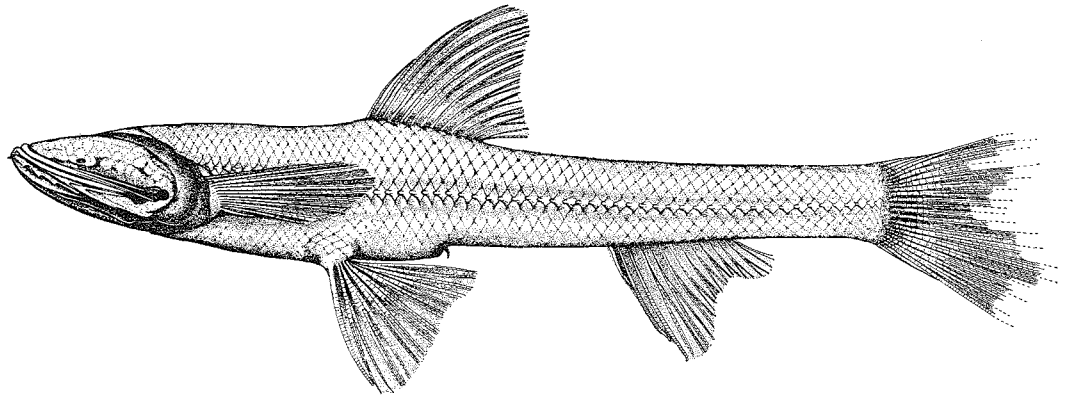


Fig. 13. Holotype of *Bathytyphlops marionae* Mead, 1958. Std.l. 279 mm. (From MEAD 1958).

Distribution:

Only known from three hauls made east of Central America, on depths from 869-2651 m (Fig. 12), i.e. at bathyal and upper abyssal depths.

Additional specimen:

Std. l. 300 mm; "Anton Bruun" cruise 8 (IIOE) St. 399 C (21°18′S, 36°18′E); 1510-1600 m; 40′ shrimp trawl; 2-10-1964.

Meristic characters: D 13, C x+18+x, A 13, P 13-14, V 8, branchiostegal rays 15, gill rakers on the anterior, dextral arch 7/1/13, lat. l. sc. 64, vertebrae 65 (25+40). – All morphometric characters agree with those mentioned in Table 9, columns 3-4, except for "Depth at ant. D", which forms 14,5 % of the std. l. – The anterior dorsal ray is placed over the 23rd vertebra. The only developed gill raker is 10 mm long and 1,5 mm broad at the basis. Pyloric coeca not present. The stomach and intestihe were empty. A narrow, testicular string was found in each gonad. The maximal egg diameter was approx. 0,5 mm.

The capture of this specimen in the Mozambique Channel has extended the distribution of *B. marionae* considerably, as it hitherto was known only from the Western Atlantic (Fig. 12). It is worth noting that this specimen was caught at a depth much shallower than the range for *B. sewelli,* yet appropriate to the range of *B. marionae* from the Western Atlantic.

GENERAL REMARKS

Reproduction:

By cutting and staining the gonads of some of the species of this family *(Bathymicrops regis* and *brevianalis, Ipnops agassizi* and *meadi, Bathytyphlops marionae)* it was found that each gonad contained both a testicular and an ovarian component. Previously, MEAD, BERTELSEN, and COHEN (1964) showed that *I. murrayi* was hermaphroditic. Suitable material of *Bathytyphlops sewelli* was not available for sectioning, but undoubtedly it is also hermaphroditic. Pl. XV, Fig. 5 shows a gonad from two species. The testicular part is seen as a lighter string medio-dorsally on the gonad. Between the anus and the genital papilla there is an ovopore. The sperm were tailless in all the specimens examined. One of the gonads from the specimen of *B. regis* caught by the "Galathea" Expedition was sectioned, and an examination of the entire series did not reveal any fertilized eggs. The diameter of the eggs varied from less than 0,1 mm to 0,6 mm (Fig. 14). One of the sections of the hermaphroditic gonads is shown on Pl. XV, Fig. 4. The sectioned gonads from the other species also contained unfertilized eggs. Gross examination of gonads from other specimens of these species showed the same (at least no cleavage could be seen).

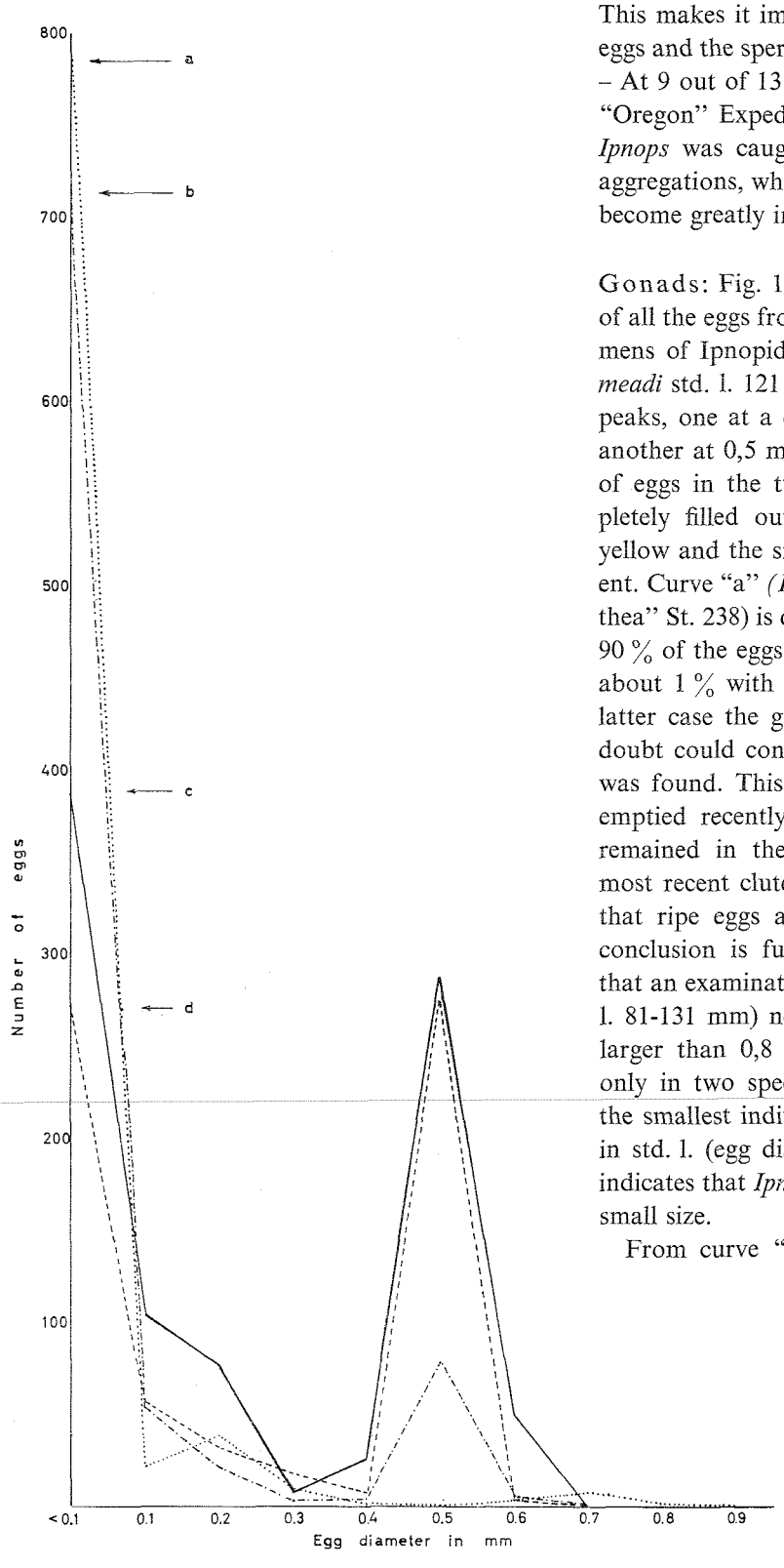
Two interpretations can be given on the basis of the above-mentioned features:

1. (Interior fertilization). It would seem most beneficial for the species if a mutual, interior fertilization took place. If this is the case it must be concluded that the eggs of the examined specimens are not yet mature, suggesting that they will grow to a larger size before being ripe. However, an examination of the gonads of 25 specimens of *Ipnops* spp. (std. l. 81-131 mm), caught at different localities in the Indian Ocean within a period of six months, did not show eggs larger than 0,8 mm in diameter (Fig. 15). Many of these specimens, with very large gonads, were apparently fully mature. The same was the case with the examined *B. regis* specimen in which the largest eggs were 0,6 mm in diameter (Pl. XV, Fig. 6). This suggests that fertilization does not take place interiorly in spite of the presence of a genital papilla.

2. (Exterior fertilization). With this method the rate of fertilization would be considerably diminished. However, the number of ripe eggs is rather small (Fig. 14). This apparent contradiction can be resolved by considering the peculiar shape of the ventral fins. Fig. 10 (p. 66) shows that the ventral fins form a more or less closed basket under the genital papilla and the ovopore, both of which are placed much anterior to the anal fin. If the ripe eggs are spent and kept in this basket, the genital papilla of another specimen could easely direct the sperm into the basket. Given external fertilization this would result in the highest rate of fertilization.

Self-fertilization is very rarely observed among fishes (MEAD 1960). The most appropriate method for hermaphroditic fishes to prevent this is by mutual interior fertilization. However, it can not be excluded that spermatozoans are able to creep on the surface of the fish from the genital papilla to the ovopore. Nonetheless, no fertilized eggs were observed in any of the ipnopids examined. If interior

fertilization does not take place, self-fertilization can be avoided if sperm and eggs do not ripen at the same time in the same specimen. – MEAD, BERTELSEN, and COHEN (1964) mention that self-fertilization might take place among deep-sea Iniomi if a specimen does not find a mate at the proper time. Sections of a gonad from five species of Ipnopidae have been made. The ovarian part of these gonads was in very different stages of ripeness, while the tailless sperm had the same appearence in all specimens. This makes it impossible to determine whether the eggs and the sperm were ripe simultaneously or not. – At 9 out of 13 stations from the "Galethea" and "Oregon" Expeditions more than one specimen of *Ipnops* was caught. Thus, they probably occur in aggregations, whereby the chances of finding a mate become greatly increased.



Gonads: Fig. 14 shows the number and diameter of all the eggs from one of the gonads of four specimens of Ipnopidae. The curve marked "c" (*Ipnops meadi* std. l. 121 mm, "Galathea" St. 282) has two peaks, one at a diameter of less than 0,1 mm and another at 0,5 mm, with roughly an equal number of eggs in the two groups. The gonad was completely filled out. Generally, the larger eggs are yellow and the smaller ones more or less transparent. Curve "a" (*Ipnops meadi* std. l. 105 mm, "Galathea" St. 238) is quite different from "c" with about 90 % of the eggs less than 0,1 mm in diameter and about 1 % with a diameter of 0,6-0,8 mm. In the latter case the gonad was only half-filled, and no doubt could contain a larger volume of eggs than was found. This may indicate that the ovary was emptied recently, and the few larger eggs which remained in the ovary were left-overs from the most recent clutch. Consequently, it can be stated that ripe eggs are 0,7-0,8 mm in diameter. This conclusion is furthermore supported by the fact that an examination of 25 specimens of *Ipnops* (std. l. 81-131 mm) never showed eggs with a diameter larger than 0,8 mm, and even these were found only in two specimens. Among the 25 specimens the smallest individual with large eggs was 92 mm in std. l. (egg diameter 0,6 mm, see Fig. 15). This indicates that *Ipnops* becomes mature at a relatively small size.

From curve "c" it may be concluded that the

Fig. 14. Number and diameter of eggs from one gonad of four specimens of Ipnopidae: a) *Ipnops meadi* n. sp. (holotype – std. l. 105 mm), b) *Ipnops agassizi* Garman, 1899 ("Galathea" St. 282 – std. l. 103 mm), c) *Ipnops meadi* n. sp. ("Galathea" St. 282 – std. l. 121 mm), d) *Bathymicrops regis* Hjort and Koefoed, 1912 ("Galathea" St. 194 – std. l. 117 mm).

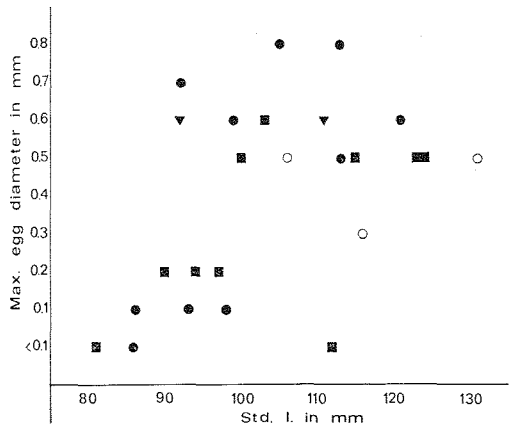


Fig. 15. Maximum egg diameter in relation to standard length in *Ipnops* spp. (For symbols see Fig. 1, p. 51).

number of eggs in a clutch (at least for specimens of *Ipnops meadi* 121 mm in std. l.) is about 600 (2×300).

It is interesting that the three specimens of *Ipnops* contained an almost equal number of eggs in the gonad examined (865, 879 and 935). There is little doubt that the two gonads from each specimen, in the present cases anyway, are alike, both concerning the number and size of the eggs. MEAD, BERTELSEN and COHEN (1964) mention that a 106 mm specimen of *Ipnops murrayi* contained 900 eggs which is only half of what is found in the present specimens, unless they also counted the eggs from one gonad only.

Fig. 14 curve "d" shows the number and size of the eggs from one of the gonads of *B. regis* (std. l. 117 mm, "Galathea" St. 194). The curve is similar to "c" with two peaks, one for a diameter less than 0,1 mm and another for 0,5 mm. There are fewer eggs than in "c" (665 *vs.* 935), but the number in the 0,5 mm groups was very alike in the two curves. However, the specimens, on which the curves "c" and "d" are based, have approx. the same length (121 and 117 mm).

Curve "b" was based on the eggs from one of the gonads of a 103 mm long *Ipnops agassizi* specimen ("Galathea" St. 314). The length of the gonad was 11 mm. By far the largest number of eggs fell within the group less than 0,1 mm in diameter, while the second peak contained only about 10 % (= approx. 85 eggs). The supposed clutch is thus considerably smaller for "b" than for "c" (85 *vs.* 300). However, this might be due to differences in the std. l. (103 *vs.* 121 mm), since a smaller specimen is unable to hold as many eggs as a larger one.

The depth of the localities for the specimens examined in Fig. 14 varies from 2600-4360 m. It is doubtful whether any seasonal variation takes place at these depths (DEARBORN (1965); MEAD, BERTELSEN and COHEN (1964); NIELSEN (1964)). Material of *I. meadi* ("Galathea" St. 238) illustrates that it is possible to find individuals with the ovaries at different stages of ripeness at the same time and in the same area. Three specimens, standard lengths 113, 105, and 98 mm, showed a maximum egg diameter of 0,8, 0,1 and 0,8 mm, respectively. Probably, the amount of food decides when a clutch of eggs will develop.

The eggs in the ovaries are placed without any sorting of sizes. Undoubtedly, judging from their relative big size and the small number in each clutch (Fig. 14), the eggs remain in the depths where they were spawned. It seems more appropriate for the eggs to occur pelagically a few metres over the bottom than to be benthic, as the number of predators is relatively large on and in the bottom. Furthermore, the soft, spherical eggs are difficult to locate when floating in the water. If the eggs or newly hatched larvae should rise to water levels richer in food than on or near the bottom, it would mean that most of the Ipnopidae known would have to travel some thousand metres during their early lives, a very risky migration. Besides, larval Ipnopidae have never been caught in nets at more shallow depths.

Biology:

As none of the specimens known were caught in closing nets it cannot be said whether they were taken on the bottom or not. However, both the fact that a bottom-trawl was used at all stations at which the present material was caught, and the fact that the ventral part of the body is flat suggest a benthic occurrence. The depths of the localities vary from bathyal (869 m) to deep abyssal depths (5850 m). All species are provided with a very large mouth which indicates that they can swallow a big prey, and *Ipnops* and *Bathymicrops* have, in addition, well-developed gill rakers which may enable them to withhold smaller food-items as well. The ipnopid fishes apparently are not provided with many means of communication (only the lateral line system is generally fairly well-developed), but they seem to live in aggregations. Larval Ipnopidae are unknown. The smallest specimen caught was 50 mm in std. l.

SUMMARY

About half of the 64 specimens of Ipnopidae treated herein were caught by the "Galathea" Expedition in 1950-52. However, as much additional material as possible from earlier and later expeditions has been included, whereby only few specimens of Ipnopidae, known to the author, were not included in this examination. – Gonads from five species, representing all three genera, were sectioned. All had both an ovarian and a testicular component. For some of the species the number and size of the eggs were examined, which showed that the eggs are separated into two size groups. Exterior fertilization appears to take place, probably by the clasped ventral fins being used as a "fertilization-room".

Ipnops pristibrachium (Fowler, 1943) is shown to be a synonym of *I. agassizi* Garman, 1899. A lectotype is designated for *I. agassizi* and for *I. murrayi* Günther, 1878. A new species, *I. meadi,* is described based on 21 specimens from lower abyssal areas of the Indo-Pacific. – A specimen of *B. regis* Hjort and Koefoed, 1912, the type species of the monotypic genus *Bathymicrops* hitherto only known from the North Atlantic, was caught in the South-West Indian Ocean. A new species, *B. brevianalis,* is described on two specimens from the Indo-West Pacific area. – A 93 mm long specimen of *Bathytyphlops sewelli* (Norman, 1939) was taken in the western Indian Ocean. Only four additional specimens are known of this genus, the smallest of which is 260 mm in standard length. It is now possible to form an idea of the allometric growth within this genus.

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